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THE NEW TORYISM.

By HERBERT SPENCER.

MOST of those who now pass as Liberals, are Tories of a new type. This is a paradox which I propose to justify. That I may justify it, I must first point out what the two political parties originally were; and I must then ask the reader to bear with me while I remind him of facts he is familiar with, that I may impress on him the intrinsic natures of Toryism and Liberalism properly so called.

Dating back to an earlier period than their names, these two political parties at first stood respectively for two opposed types of social organization, broadly distinguishable as the militant and the industrial—types which are characterized, the one by the *régime* status, almost universal in ancient days, and the other characterized by the *régime* of contract, which has become general in modern days, chiefly among the Western nations, and especially among ourselves and the Americans. If, instead of using the word "co-operation" in a limited sense, we use it in its widest sense, as describing the combined activities of citizens under whatever system of regulation, then these two are definable as the system of compulsory co-operation and the system of voluntary co-operation. The typical structure of the one we see in an army formed of conscripts, in which the units in their several grades have to fulfill commands under pain of death, and receive food and clothing and pay arbitrarily apportioned; while the typical structure of the other we see in a body of producers or distributors, who severally agree to specified salaries and wages in return for specified services, and may at will, after due notice, leave the organization if they do not like it.

During social evolution in England, the distinction between these two fundamentally-opposed forms of co-operation made its appearance

gradually; but long before the names Tory and Whig came into use, the parties were becoming traceable, and their connections with militancy and industrialism respectively were vaguely shown. The truth is familiar that here, as elsewhere, it was habitually by town-populations, formed of workers and traders accustomed to co-operate under contract, that resistances were made to that coercive rule which characterizes co-operation under status. While conversely, support of co-operation under status, arising from, and adjusted to, chronic warfare, came from rural districts, originally peopled by military chiefs and their dependents, which retained the primitive ideas and traditions. Moreover, this contrast in political leanings, shown before Whig and Tory principles became clearly distinguished, continued to be shown afterward. At the period of the Revolution, "while the villages and smaller towns were monopolized by Tories, the larger cities, the manufacturing districts, and the ports of commerce, formed the strongholds of the Whigs"; and that, spite of exceptions, the like general relation still exists, needs no proving.

Such were the natures of the two parties as indicated by their origins. Observe, now, how their natures were indicated by their early doctrines and deeds. Whiggism began with resistance to Charles II and his cabal, in their efforts to re-establish unchecked monarchical power. The Whigs "regarded the monarchy as a civil institution, established by the nation for the benefit of all its members"; while with the Tories "the monarch was the delegate of Heaven." And these doctrines involved the beliefs, the one that subjection of citizen to ruler was conditional, and the other that it was unconditional. Describing Whig and Tory as conceived at the end of the seventeenth century, some fifty years before he wrote his "Dissertation on Parties," Bolingbroke says:

> The power and majesty of the people, an original contract, the authority and independency of Parliaments, liberty, resistance, exclusion, abdication, deposition; these were ideas associated, at that time, to the idea of a Whig, and supposed by every Whig to be incommunicable, and inconsistent with the idea of a Tory.
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> Divine, hereditary, indefeasible right, lineal succession, passive-obedience, prerogative, non-resistance, slavery, nay, and sometimes popery too, were associated in many minds to the idea of a Tory, and deemed incommunicable and inconsistent, in the same manner, with the idea of a Whig ("Dissertation on Parties," p. 5).

And if we compare these descriptions, we see that in the one party there was a desire to resist and decrease the coercive power of the ruler over the subject, and in the other party to maintain or increase his coercive power. This distinction in their aims—a distinction which transcends in meaning and importance all other political distinctions—was displayed in their early doings. Whig principles were exemplified in the Habeas Corpus Act, and in the measure by which judges

were made independent of the Crown; in defeat of the Non-Resisting Test Bill, which proposed for legislators and officials a compulsory oath, that they would in no case resist the king by arms; and later, they were exemplified in the Bill of Rights, framed to secure subjects against monarchical aggressions. These acts had the same intrinsic nature. The principle of compulsory co-operation throughout social life was weakened by them, and the principle of voluntary co-operation strengthened. That at a subsequent period the policy of the party had the same general tendency is well shown by a remark of Mr. Green concerning the period of Whig power after the death of Anne:

> Before the fifty years of their rule had passed, Englishmen had forgotten that it was possible to persecute for differences of religion, or to put down the liberty of the press, or to tamper with the administration of justice, or to rule without a Parliament (Green, 705).

And now, passing over the war-period which closed the last century and began this, during which the extension of individual freedom previously gained was lost, and the retrograde movement toward the social type proper to militancy was shown by all kinds of coercive measures, from those which took by force the persons and property of citizens for war purposes to those which suppressed public meetings and sought to gag the press, let us recall the general characters of those changes effected by Whigs, or Liberals, after the re-establishment of peace permitted revival of the industrialism *régime*, and return to its appropriate type of structure. Under growing Whig influence there came repeal of the laws which forbade combination among artisans as well as of those which interfered with their freedom of traveling. There was the measure by which, under Whig pressure, Dissenters were allowed to believe as they pleased without suffering certain civil penalties; and there was the Whig measure, carried by Tories from compulsion, which enabled Catholics to profess their religion without losing part of their civil freedom. The area of liberty was extended by acts which forbade the buying of negroes and the holding them in bondage. The political serfdom of the unrepresented was narrowed in area, both by the Reform Bill and the Municipal Reform Bill; so that, both generally and locally, the many were less under the coercion of a few. Later came diminution and removal of restraints on the buying of foreign commodities and the employment of foreign vessels; and later still the removal of those burdens on the press, which were originally imposed to hinder the diffusion of opinion. And of all these changes it is unquestionable that, whether made or not by Liberals themselves, they were made in conformity with the principles professed and urged by Liberals.

But why do I enumerate facts so well known to all? Simply because, as intimated at the outset, it seems needful to remind every-

body what Liberalism was in the past, that they may perceive its unlikeness to the so-called Liberalism of the present. It would be inexcusable to name these various measures for the purpose of pointing out the character common to them, were it not that in our day men have forgotten their common character. They do not remember that in one or other way all these truly Liberal changes diminished compulsory co-operation throughout social life and increased voluntary co-operation. They have forgotten that, in one direction or other, they diminished the range of governmental authority, and increased the area within which each citizen may act unchecked. They have lost sight of the truth that in past times Liberalism habitually stood for individual freedom *versus* state coercion.

And now comes the inquiry, How is it that Liberals have lost sight of this? How is it that Liberalism, getting more and more into power, has grown more and more coercive in its legislation? How is it that, either directly through its own majorities or indirectly through aid given in such cases to the majorities of its opponents, Liberalism has, to an increasing extent, adopted the policy of dictating the actions of citizens, and, by consequence, diminishing the range throughout which their actions remain free? How are we to explain this spreading confusion of thought which has led it, in pursuit of what appears to be public good, to invert the method by which in earlier days it achieved public good?

Unaccountable as at first sight this unconscious change of policy seems, we shall find that it has arisen quite naturally. Given the unanalytical thought ordinarily brought to bear on political matters, and under existing conditions, nothing else was to be expected. To make this clear, some parenthetic explanations are needful.

From the lowest to the highest creatures, intelligence progresses by acts of discriminations; and it continues so to progress among men, from the most ignorant to the most cultured. To class rightly—to put in the same group things which are of essentially the same natures, and in other groups things of natures essentially different—is the fundamental condition to right guidance of actions. Beginning with rudimentary vision, which gives warning that some large opaque body is passing near (just as closed eyes turned to the window, perceiving the shade caused by a hand put before them, tell us of something moving in front), the advance is to developed vision, which, by exactly-appreciated combinations of forms, colors, and motions, identifies objects at great distances as prey or enemies of this or that kind, and so makes possible adjustments of conduct for securing food or evading death. That progressing perception of differences and consequent greater correctness of classing constitutes under one of its chief aspects the development of mind, is equally seen when we pass from the relatively simple physical vision to the relatively complex intellectual vision—

the vision through the agency of which things previously grouped by certain external resemblances or by certain extrinsic circumstances come to be more truly grouped in conformity with their intrinsic structures or natures. Undeveloped intellectual vision is just as indiscriminating and erroneous in its classings as undeveloped physical vision. Instance the early arrangement of plants under the heads trees, shrubs, and herbs: size, the most conspicuous trait, being the ground of distinction, and the assemblages formed being such as united many plants extremely unlike in their natures, and separated others that are near akin. Or still better, take the popular classification which puts together under the same general name fish and shell-fish, and under the sub-name, shell-fish, puts together crustaceans and mollusks; nay, which goes further, and regards as fish the cetacean mammals. Partly because of the likeness in their modes of life as inhabiting the water, and partly because of some general resemblance in their tastes, creatures that are in their essential natures far more widely separated than a fish is from a bird, are grouped under the same class and under the same sub-class.

Now, the general truth thus exemplified holds throughout those higher ranges of intellectual vision concerned with things not presentable to the senses, and, among others, such things as political institutions and political measures. For among these, too, we shall find that the results of inadequate intellectual faculty, or inadequate culture of it, or both, are erroneous classings and consequent erroneous conclusions. Indeed, the liability to error is here much greater, since the things with which the intellect is concerned do not admit of examination in the same easy way. You can not touch or see a political institution: it can be known only by an effort of constructive imagination. Neither can you apprehend by physical perception a political measure: this still more requires a process of mental representation by which its elements are put together in thought, and the essential nature of the combination conceived. Here, therefore, still more than in the cases above named, defective intellectual vision is shown in grouping by external characters or extrinsic circumstances. How institutions are wrongly classed from this cause, we see in the common notion that the Roman Republic was a popular form of government. Look into the early ideas of the French revolutionists who aimed at an ideal state of freedom, and you find that the institutions and doings of the Romans were their models; and even now an historian might be named who instances the corruptions of the Roman Republic as showing us what popular government leads to. Yet the resemblance between the institutions of the Romans and free institutions properly so called was less than that between a shark and a porpoise—a resemblance of general external form accompanying widely different internal structures. For the Roman Government was that of a small oligarchy within a larger oligarchy, the members of each being unchecked autocrats. A

society in which the only men who had political power, and were in a qualified sense free, were so many petty despots, holding not only slaves and dependents but even children in the same absolute bondage as they held their cattle, is, in its intrinsic nature, more nearly allied to an ordinary despotism than it is to a society of citizens politically equal.

Passing now to our special question, we may understand the kind of confusion in which Liberalism has lost itself, and the origin of those mistaken classings of political measures which have misled it—classings, as we shall see, by conspicuous external traits instead of by internal natures. For what, in the popular apprehension and in the apprehension of those who effected them, were the changes made by Liberals in the past? They were abolitions of grievances suffered by the people, or by portions of them: this was the common trait of them which most impressed itself on men's minds. They were mitigations of evils which had directly or indirectly been felt by large classes of citizens, as causes of misery or as hindrances to happiness. And since in the minds of most a rectified evil is equivalent to an achieved good, these measures came to be thought of as so many positive benefits; and the welfare of the many came to be conceived alike by Liberal statesmen and Liberal voters as the aim of Liberalism. Hence the confusion. The gaining of a popular good being the external conspicuous trait common to Liberal measures in earlier days (then in each case gained by a relaxation of restraints), it has happened that popular good has come to be sought by Liberals, not as an end to be indirectly gained by such relaxations, but as the end to be directly gained. And, seeking to gain it directly, they have used methods intrinsically opposed to those originally used.

And now, having seen how this reversal of policy has arisen (or partial reversal, I should say, for the recent Burials Act, and the efforts to remove all remaining religious inequalities, show continuance of the original policy in certain directions), let us proceed to contemplate the extent to which it has been carried during recent times, and the still greater extent to which the future will see it carried if current ideas and feelings continue to predominate.

Before proceeding, it may be well to say that no reflections are intended on the motives which have prompted one after another of these various restraints and dictations. These motives were doubtless in nearly all cases good. It must be admitted that the restrictions, placed by an act of 1870 on the employment of women and children in Turkey-red dye-works, were, in intention, no less philanthropic than those of Edward VI, which prescribed the minimum time for which a journeyman should be retained. Without question, the Seed Supply (Ireland) Act of 1880, which empowered guardians to buy seed for poor tenants, and then to see it properly planted, was moved by a de-

sire for public welfare no less great than that which in 1533 prescribed the number of sheep a tenant might keep, or that of 1597, which commanded that decayed houses of husbandry should be rebuilt. Nobody will dispute that the various measures of late years taken for restricting the sale of intoxicating liquors, have been taken as much with a view to public morals as were the measures taken of old for checking the evils of luxury, as, for instance, in the fourteenth century, when diet as well as dress was restricted. Every one must see that the edicts issued by Henry VIII, to prevent the lower classes from playing dice, cards, bowls, etc., were not more prompted by desire for popular welfare than were the acts passed of late to check gambling.

Further, it is no part of my present purpose to question the wisdom of these modern interferences, which Conservatives and Liberals vie with one another in multiplying, any more than the wisdom of those ancient ones which they in many cases resemble. We will not here consider whether the plans of late adopted for preserving the lives of sailors are or are not more judicious than that sweeping Scotch measure which, in the middle of the fifteenth century, prohibited vessels from sailing during the winter. For the present, it shall remain an open question whether there is a better warrant for giving the police powers to search certain provision-dealers' premises for unfit food than there was for the law of Edward III, under which innkeepers at seaports were sworn to search their guests to prevent the exportation of money or plate. We will assume that there is no less wisdom in that clause of the Canal-boat Act, which forbids an owner to gratuitously board the children of the boatmen, than there was in the Spitalfields Acts, which up to 1824, for the benefit of the aritsans, forbade the manufacturers to fix their factories more than ten miles from the Royal Exchange.

We exclude, then, these questions of philanthropic motive and wise judgment, taking both of them for granted, and have here to concern ourselves solely with the compulsory nature of the measures which, for good or evil, as the case may be, have been put in force during periods of Liberal ascendency.

To bring the illustrations within compass, let us commence with 1860, under the second administration of Lord Palmerston. In that year, the restrictions of the Factory Act were extended to bleaching and dyeing works; authority was given to provide analysts to be paid out of local rates; there was an act providing for inspection of gas-works, as well as for fixing quality and limits of price; there was the act which, in addition to further mine-inspection, made it penal to employ boys under twelve unable to read and write; and there were further provisions for cheap locomotion on railways. In 1861 occurred an extension of the compulsory provisions of the Factory Act to lace-works; power was given to poor-law guardians, etc., to enforce vaccination; local boards were authorized to make improvements in

private property, and charge to the owner; and certain locally-formed bodies had given them power of taxing the locality for rural drainage and irrigation works, and for supplying water to cattle. In 1862 an act was passed for restricting the employment of women and children in open-air bleaching, and an act for making illegal a coal-mine with a single shaft, or with shafts separated by less than a specified space. In 1863 came the extension of compulsory vaccination to Scotland, and also to Ireland; there came the empowering of certain boards to take from rate-payers money to employ and pay those out of work; there came the empowering of town authorities to take possession of neglected ornamental spaces, and rate the inhabitants for their support; and there came the Bakehouses Regulation Act, which, besides specifying minimum age of employés occupied between certain hours, prescribed periodical lime-washing, three coats of paint when painted, and washing with hot water and soap at least once in six months. Of compulsory legislation dating from 1864, may be named an extension of the Factory Act to various additional trades, including regulations for cleansing and ventilation, and specifying of certain employés in match-works that they might not take meals on the premises except in the wood-cutting places. Also there were passed the Chimney-Sweepers Act, the act for further regulating public-house closing, the act for compulsory testing of cables and anchors, and the Contagious Diseases Act, which last gave the police, in specified places, powers which, in respect of certain classes of women, abolished sundry of those safeguards to individual freedom established in past times. The year 1865 witnessed further provision for the reception and temporary relief of wanderers at the cost of rate-payers; and another public-house closing act containing sixty-four amendments. Then, under the ministry of Lord John Russell, in 1866, have to be named an act to regulate cattle-sheds, etc., in Scotland, giving local authorities power to inspect sanitary condition, and fix number of cattle; an act forcing hop-growers to label their bags with the year and place of growth, and the true weight, and giving police power of inspection; an act to facilitate the building of lodging-houses in Ireland, and providing for regulation of the inmates; a Public Health Act, under which there is registration of lodging-houses and limitation of occupants, with inspection and directions for lime-washing, etc.; and a Public Libraries Act, giving local powers by which a majority can tax a minority for their books.

Passing now to the legislation under the first ministry of Mr. Gladstone, we have, in 1870, the establishment of state-telegraphy, with the accompanying interdict on telegraphing by any other agency; we have inspection, not only of endowed schools but of registered private schools, and dismissal, without appeal, of teachers and officials not approved; we have a law authorizing the Board of Public Works to give compensation for landlord's improvements; we have the act which

enables the Education Department to provide school-boards, purchase sites for schools, provide free schools supported by local rates, and enabling school-boards to pay a child's fees, to compel parents to send their children, etc., etc.; we have a further Factories and Workshops Act, making, among other restrictions, some on the employment of women and children in fruit-preserving and fish-curing works. In 1871 we meet with an amended Merchant Shipping Act, directing officers of the Board of Trade to record the draught of sea-going vessels leaving port; there is another Factory and Workshops Act, making further restrictions; there is a Peddlers' Act, inflicting penalties for hawking without a certificate, and limiting the police-district within which the certificate holds, as well as giving the police power to search peddlers' packs; and there are further measures for enforcing vaccination. The year 1872 had, among other acts, one which makes it illegal to take for hire more than one child to nurse, unless in a house registered by authorities, who prescribe the number of infants to be received; it had a Licensing Act, interdicting sale of spirits to those under sixteen; and it had another Merchant Shipping Act, establishing an annual survey of passenger-vessels, as well as an interdict against pilots who are not licensed. Then, in 1875, was passed the Agricultural Children's Act, which made it illegal for a farmer to employ a child who has no certificate of elementary education; and there was passed a Merchant Shipping Act, requiring, on each vessel, a scale showing draught, requiring examination of officers, and prescribing the number of boats and life-preservers. Turn now to Liberal law-making under the present ministry. We have, in 1880, a law which forbids conditional advance-notes in payment of sailors' wages; and also a law which dictates certain arrangements for the safe carriage of grain-cargoes. In 1881 comes legislation to prevent trawling over clam-beds and bait-beds, and an interdict making it impossible to buy a glass of beer on Sunday in Wales. In 1882 corn-factors were required, under a penalty of twenty pounds, to furnish for publication a weekly return of their transactions; municipal bodies were enabled to levy rates for electric lighting; further exactions from rate-payers were authorized for facilitating more accessible baths and wash-houses; and local authorities were empowered to make by-laws for securing the decent lodging of persons engaged in hop-picking, or picking fruit and vegetables. Then, finally, of such legislation during the last session may be named the Cheap Trains Act, which, partly by taxing the nation to the extent of £400,000 a year (in the shape of relinquished passenger duty), and partly at the cost of railway-proprietors, still further cheapens traveling for workmen: the Board of Trade, through the Railway Commissioners, being empowered to insure sufficiently good and frequent accommodation. Again, there is the act which, under penalty of ten pounds for disobedience, forbids the payment of wages to workmen at or within public-houses; there is another Factory and Work-

shops Act, commanding inspection of white-lead works and bake-houses, regulating times of employment in both, and prescribing in detail some constructions for the last, which are to be kept in a condition satisfactory to the inspectors.

But we are far from forming an adequate conception if we look only at the compulsory legislation which has actually been established of late years. We must look also at that which is advocated, and which threatens to be far more sweeping in range and stringent in character. We have lately had a cabinet minister, one of the most advanced Liberals, so called, who pooh-poohs the plans of the late Government for improving industrial dwellings as so much "tinkering"; and contends for effectual coercion to be exercised over owners of small houses, over land-owners, and over rate-payers. Here is another cabinet minister who, addressing his constituents, speaks slightingly of the doings of philanthropic societies and religious bodies to help the poor, and (apparently ignoring the Poor Law) says that "the whole of the people of this country ought to look upon this work as being their own work"; that is to say, some wholesale government measure is called for. Here, again, is a radical member of Parliament, who leads a large and powerful body, aiming, with annually-increasing promise of success, to enforce sobriety by giving to local majorities power to prevent freedom of exchange in respect of certain commodities. There is a rising demand, too, that education shall be made gratis for all: the payment of school-fees is beginning to be denounced as a wrong—the state must take the whole burden. Moreover, it is proposed by many that the state, regarded as an undoubtedly competent judge of what constitutes good education for the poor, shall undertake also to prescribe good education for the middle classes—shall stamp the children of these, too, after a state pattern, concerning the goodness of which they have no more doubt than the Chinese had when they fixed theirs. Then there is the "endowment of research," of late energetically urged. Already the Government gives every year the sum of many thousand pounds for this purpose, to be distributed through the Royal Society; and, in the absence of those who have much interest in resisting, the pressure of the interested, backed by those they easily persuade, may by-and-by establish that paid "priesthood of science" long ago advocated by Sir David Brewster. Once more, plausible proposals are made that there should be organized a system of compulsory insurance, by which men during their early lives shall be forced to provide for the time when they will be incapacitated.

Nor does enumeration of these further measures of coercive rule, looming upon us near at hand or in the distance, complete the account. Nothing more than cursory allusion has yet been made to that accompanying compulsion which takes the form of increased taxation, general and local. Partly for defraying the costs of carrying out those ever-multiplying coercive measures, each of which requires an

additional staff of officers, and partly to meet the outlay for new public institutions, such as board-schools, free libraries, public museums, baths and wash-houses, recreation-grounds, etc., local rates are year after year increased, as the general taxation is increased by grants to the departments of science and art, etc. Every one of these involves further coercion—restricts still more the free action of the citizen. For the implied address accompanying every additional exaction is: "Hitherto you have been free to spend this portion of your earnings in any way which pleased you; hereafter you shall not so spend it, but we will spend it for the general benefit." Thus, either directly or indirectly, and in most cases both at once, the citizen is, at each further stage in the growth of this compulsory legislation, deprived in one or other way of some liberty which he previously had.

Such, then, are the doings of the party which claims the name of Liberal, and which calls itself Liberal as being the advocate of extended freedom.

I doubt not that many a so-called Liberal will have read the preceding section with impatience, wanting, as he does, to point out an immense oversight which he thinks destroys the validity of the argument. "You forget," he wishes to say, "the fundamental difference between the power which, in the past, established those restraints that Liberalism abolished, and the power which, in the present, establishes the restraints you call anti-Liberal. You forget that the one was an irresponsible power, while the other is a responsible power. You forget that, if by the recent legislation of Liberals people are variously regulated, the body which regulates them is of their own creating, and has their warrant for its acts."

My answer is, that I have not forgotten this difference, but am prepared to contend that the difference is in large measure irrelevant to the issue.

In the first place, the real issue is whether the lives of citizens are more interfered with than they were; not the nature of the agency which interferes with them. Take a simpler case. A member of a trades-union has joined others in establishing an organization of a purely representative character. By it he is compelled to turn out if a majority so decide; he is forbidden to accept work save under the conditions they dictate; he is prevented from profiting by his superior ability or energy to the extent he might do were it not for their interdict. And he can not disobey without abandoning those pecuniary benefits of the organization for which he has subscribed, and bringing on himself the persecution, and perhaps violence, of his fellows. Is he any the less coerced because the body coercing him is one which he had an equal voice with the rest in forming?

In the second place, if it be objected that the analogy is faulty, since the governing body of a nation, to which, as protector of the

national life and interests, all must submit under penalty of social disorganization, has a far higher authority over citizens than the government of any private organization can have over its members; then the reply is that, granting the difference, the answer made continues valid. If men use their liberty in such a way as to surrender their liberty, are they thereafter any the less slaves? If people by a *plébiscite* elect a man despot over them, do they remain free because the despotism was of their own making? Are the coercive edicts issued by him to be regarded as legitimate because they are the ultimate outcome of their own votes? As well might it be argued that the savage who breaks a spear in another's presence that he may so become bondsman to him, still retains his liberty because he freely chose his master.

Finally, if any—not without marks of irritation, as I can imagine—protest against this reasoning, and say that there is no true parallelism between the relation of people to government where an irresponsible single ruler has been permanently elected, and the relation where a responsible representative body is maintained, and from time to time re-elected, then there comes the ultimate reply—an altogether heterodox reply—by which most will be greatly astonished. This reply is, that these multitudinous restraining acts are not defensible on the ground that they proceed from a popularly chosen body; for that the authority of a popularly chosen body is no more to be regarded as an unlimited authority than the authority of a monarch; and that as true Liberalism in the past disputed the assumption of a monarch's unlimited authority, so true Liberalism in the present will dispute the assumption of unlimited parliamentary authority. Of this, however, more anon. Here I merely indicate it as an ultimate answer.

Meanwhile it suffices to point out that until recently, just as of old, true Liberalism was shown by its acts to be moving toward the theory of a limited parliamentary authority. All these abolitions of the restraints over religious beliefs and observances, over exchange and transit, over trade combinations and the traveling of artisans, over the publication of opinions, theological or political, etc., etc., were tacit recognitions of the propriety for limitation. In the same way that the final abandonment of sumptuary laws, of laws forbidding this or that kind of amusement, of laws dictating modes of farming, and many others of like meddling nature, which took place in early days, was an implied admission that the state ought not to interfere in such matters; so were those removals of hindrances to individual activities of one or other kind, which the Liberalism of the last generation effected, practical confessions that in these directions, too, the sphere of governmental action should be narrowed. And this recognition of the propriety of narrowing governmental action was a preparation for narrowing it in theory. One of the most familiar political truths is that, in the course of social evolution, usage precedes law, and that, when

usage has become well established, it becomes law by receiving authoritative recognition and defined form. Manifestly, then, Liberalism in the past, by its practice of limitation, was preparing the way for the principle of limitation.

But, returning from these more general considerations to the special question, I emphasize the reply that the liberty which a citizen enjoys is to be measured, not by the nature of the governmental machinery he lives under, whether representative or other, but by the number and degree of the restraints it imposes on him ; and that, whether this machinery is or is not one which he has shared in making, its actions are not of the kind proper to Liberalism if they increase such restraints beyond those which are needful for preventing him from directly or indirectly aggressing on his fellows—needful, that is, for maintaining the liberties of his fellows against his invasions of them ; restraints which are, therefore, to be distinguished as negatively coercive, not positively coercive.

I doubt not, however, that the Liberal, and still more the subspecies Radical, who more than any other in these latter days seems under the impression that so long as he has a good end in view he is warranted in exercising over men all the coercion he is able, will continue to protest. Knowing that his aim is popular benefit of some kind, to be achieved in some way, and believing that the Tory is, contrariwise, prompted by class-interest and the desire to maintain class-power, he will regard it as palpably absurd to group him as one of the same genus—will scorn, as mere chop-logic, the reasoning used to prove this.

Perhaps an analogy will help him to see its validity. If, away in the far East, where personal government is the only form of government known, he heard from the inhabitants the account of a struggle by which they had deposed a cruel and vicious despot, and put in his place one whose acts proved his desire for their welfare—if, after listening to their self-gratulations, he told them that they had not essentially changed the nature of their government, he would greatly astonish them ; and probably he would have difficulty in making them understand that the substitution of a benevolent despot for a malevolent despot still left the government a despotism. Similarly with Toryism as rightly conceived. Standing as it does for coercion by the state *versus* the freedom of the individual, Toryism remains Toryism, whether it extends this coercion for selfish or unselfish reasons. As certainly as the despot remains a despot, whether his motives are good or bad, so certainly does the Tory remain a Tory, whether he has egoistic or altruistic motives for using state-power to restrict individual liberty, beyond the degree required for maintaining the liberties of other individuals. The altruistic Tory as well as the egoistic Tory belongs to the genus Tory, though he forms a new species of the genus. And both stand in distinct contrast with the Liberal as defined

in the days when Liberals were rightly so called, and when the definition was, "one who advocates greater freedom from restraint, especially in political institutions."

Thus, then, is justified the paradox I set out with. As we have seen, Toryism and Liberalism originally emerged, the one from militancy, and the other from industrialism. The one stood for the *régime* of status, and the other for the *régime* of contract—the one for that system of compulsory co-operation which accompanies the legal inequality of classes, and the other for that voluntary co-operation which accompanies their legal equality; and beyond all question the early acts of the two parties were respectively for the maintenance of agencies which effect this compulsory co-operation, and for the diminution of them. Manifestly the implication is that, in so far as it has been extending the system of compulsion, what is now called Liberalism is a new form of Toryism.

How truly this is so, we shall see still more clearly on looking at the facts the other side upward, which we will presently do.

COLLEGE ATHLETICS.

By EUGENE L. RICHARDS,

ASSISTANT PROFESSOR OF MATHEMATICS IN YALE COLLEGE.

I.—ADVANTAGES.

VERY few persons will dissent from the proposition that students should exercise their bodies. If called upon to state the amount and kind of exercise needed, most people would be at a loss to prescribe these particulars, and would content themselves with the usual generalities about its being essential to health; that it should be so regulated as to be recreative, but not so excessive as to be exhausting. There are numbers of intelligent men who, even assenting to these generalities, never wake to the real truth of them till a violated law of nature inflicts its penalty in their own ill health. However, we must assume that we shall have the assent of sensible people if we start with two principles: first, that young men who study need exercise; and, second, that exercise, to be beneficial, should be regular and systematic. If we can show that college athletics supply this need to quite a large body of students, and supply it regularly and systematically, we may secure a patient consideration of their good effects long enough to add a discussion of their accompanying evils. In this discussion we hope to prove that the evils have been exaggerated; that they are not so great as would be the evils of a college-life without a system of athletics; and, lastly, that such evils as do inhere in the present system are capable of remedy.

In order to give foundation and strength to our belief in the benefits of physical exercise, let us consider what it does, and how really necessary it is. Though we admit the truth of all the wise sayings with regard to a "sane mind in a sound body," we are yet too apt to regard the sound body as a mere accident of inheritance or environment. So we read the proposition as an hypothetical one, viz., "If the body is sound, the mind will be sane." Few but physicians read it as indicating a connection between body and mind, by means of which we can make, or help to make, a good healthy brain by making a good sound body. In the fact that the brain always seems to direct the body, we are prone to forget that the body carries the brain and feeds it with its own life. If the body has good blood, the brain will have good blood also. If the body does not furnish good material, the brain will do, according to its capacity, poor work, or will not work at all. That many men of weak bodies have done good brain-work in their day is true, but many such men have been hindered from doing better work by physical weakness. Moreover, can any man say that the work done would not have been greater or better if the men doing it had had better bodies? After the body has attained maturity, most men recognize the connection and sympathy between mind and body. During the time of growth, however, this interdependence is often taken into small account.

There are two kinds of brain-work—one which we may very properly call body brain-work, and the other mind brain-work.* Most people, including a great many educators of youth, consider mind brain-work to be the only kind of brain-work. But body brain-work is quite as essential to the healthy existence of the brain, and really comes first in the order of brain-growth. The child, too young to know anything except its bodily wants, and conscious of them only when the denial of them causes pain, develops brain every time it makes a will-directed effort to grasp the thing it wants. The movement of its hand is as necessary to the development of its brain as the guidance and government of the brain are to the growth of the hand. What is true of the hand is true of the other bodily organs whose motion is under the control of the will. They and the brain are developed by reciprocal action. Interfere with this body brain-work in childhood, or at any period of growth, either by repressing it or by diverting from it too much vital energy to mind brain-work, such as is involved in the acquisition of knowledge, and you not only stunt the body, but also enfeeble the brain, by depriving both of their proper growth. The worst feature of such interference, at such a time, is that the evil then done can not be remedied, and the power lost to body and brain can never be regained.

Care to guard against this interference is all the more necessary in cases in which the brain is large or sensitive. Now, will any man say

* Dr. Clarke, "Building of a Brain."

that at the time of life when young men come to our American colleges, when, in fact, all their bodily organs are approaching maturity, this body brain-work ought to cease, or can, without danger, be neglected? Is it not most essential that at this very period the reciprocal action between body and brain should be steadily maintained, in order that both should be able to endure the strain put upon them by the various stimulants of thought and feeling to be found in college-life? The great pressure brought to bear upon them is toward conscious cerebration. Acquisitions of knowledge, scholarships, the ambitious desires of parents, and prizes, all incite them to neglect body brain-work, under the mistaken impression that time given to that is time lost to the other. Many a fine scholar has left college with great honors, to experience in his subsequent career the serious results of the mistake made in college, and has discovered, often too late, that a vigorous body to carry his brain is more essential to success in life than a well-trained brain full of knowledge but lacking a strong body from which to draw its nourishment and strength.

Again, exercise, to be beneficial, should be regular and systematic. To be most beneficial it should be in the open air. The oxygenation of the blood is not the least important effect of exercise. In consequence of the reciprocal action of mind and body, to be as beneficial as possible it should be accompanied by mental occupation. The mind should be interested in the exercise while the body is engaged. How shall all these requisites of the best kind of exercise be secured? First, a regularly set *time* for exercise; next, a fixed *amount* of time devoted to it; then a *place* where the lungs should breathe fresh air; and, lastly, a *kind* of exercise which should engage the mind as well as the body. By the present system of college athletics these requisites are met, if not perfectly, at least as well as it is possible for them to be met. If the millennium had come, and all men, and especially young men, would do right, without any compulsion, and simply because it is the only thing to do, we might come to a settlement of these important particulars of exercise for our students. The regularity of the exercise, and the amount of time devoted to it, could easily be arranged. There could be no question as to the expediency of taking it in the open air. But how secure the co-operation of the mind? How make bodily exercise interesting, so that a man will desire to take it and will take it with gladness, not making a burden of it, and not considering it as a duty merely? That is the real problem to solve, when we set ourselves to the task of prescribing the right kind of exercise. Very few can be induced to exercise from a sense of duty. The majority go without it till they suffer illness from the want of it, and then prefer a doctor's remedies to Nature's. Here athletics accomplish the greatest good. They do furnish a mental stimulus. They set up an object to be striven for, and an ideal of strength or skill. The object is honor—honor of no great worth, perhaps, but still honor

to the student-mind. In boating, the object is a victory over a crew of a rival class or a rival college. In lacrosse, base-ball, and foot-ball, besides working for the ultimate object of the championship, the mind of the player has continual occupation in the game itself. To secure a victory in any of these sports, good brains in the players contribute quite as much as good muscles. In fact, it is the skilled muscles rightly directed by good brains which win, and not the players most skilled in the use of their muscles. Mind as well as body has to be considered by the successful captains in the selection of their men. Then there are minor considerations which keep students in steady training, and help to induce more men to work than finally appear in the great contests, such, for instance, as the ambition to secure an office or position in one of the university organizations, and thus an honorable standing as a college man. These various considerations not only accompany the men into the field or at the oar, but also, when they are prevented from taking out-door practice, send them into the gynmasium to prepare for the later work.

The following brief account of the exercise taken by the students is offered in order to insure a better understanding of the system of college athletics:

Almost as soon as the college opens in the fall, the various class nines begin their games for the college championship. At the same time the class crews, the foot-ball and lacrosse teams put their men into training. This means regular exercise in the open air from four to six weeks for about one hundred and forty men. Quite as many more are benefited, some by actual participation in the games, in order to furnish opponents to the teams in practice, and others by training for the Athletic Association contests. After the class base-ball championship is decided, and the Athletic Association meetings have terminated, fewer men exercise. The interest of the college then centers in the Foot-ball Elevens, one selected from the whole university, and the other from the freshman classes of the academic and scientific departments. To give these teams practice, all the college is urged to go to the field and play against them; and though, of course, the invitation is not accepted as extensively as it is given, yet it does induce quite a large number of men to exercise. But this is not the only good effect of the existence of these teams. Catching the enthusiasm of the sport, often the men of different dormitories and of different eating-clubs send out teams for matches. The foot-ball season terminates at the thanksgiving recess. The two or three weeks intervening between this recess and the winter examinations see very little exercise taken by the students, except by the few who regularly use the gymnasium. Immediately on the opening of the winter term activity in athletics manifests itself again. The captain of the University Crew, the captain of the University Base-ball Nine, the captains of the different class crews, and the captain of the Freshman Base-ball Nine, call

for men who wish to try for positions on these organizations. The candidates are put into regular training in the gymnasium, while the season prevents exercise out-of-doors. Nearly a hundred men come forward, who are actually in training for at least one hour a day. They are required to live rightly in all respects. Each man is bound to avoid excesses of all kinds. The force of a public opinion created by the sight of these men attending to their physical development, and living according to laws and rules, acts upon the college world to encourage regularity of life and obedience to authority. It is a moral power in the community. As soon as the season permits, the men are sent out-of-doors. The crews take their seats in the boats. The nines take their positions in the field. The spring regatta terminates the practice of the class crews, but, as that event occurs about three weeks before the June examinations, and five weeks before the close of the college year, it does not leave the young men a long time without exercise. The University, Consolidated, and Freshman Nines, the Lacrosse Team, and the University Crew (with sometimes a second eight), continue their practice much longer, some of them stopping work only after the close of the college year.

Now, it may be said that the writer has only shown that regular exercise has been secured during a few weeks of the first term to one hundred and forty men at the most, and during the whole winter term to one hundred men; and in the spring and summer to one hundred men part of the term, and to half that number during the whole of the term. Granted. But there are other organizations which induce men to exercise. The Athletic Association has already been mentioned. This gives three exhibitions; one during the winter or early spring in the gymnasium, and two in the open air, one in the summer and one in the fall. The Dunham Rowing Club has a membership of forty-four men. Then there are canoe clubs, tennis clubs, and gun clubs. It would be putting the estimate too low to say that at least half of the undergraduate members of the academic and scientific departments get quite a regular amount of systematic out-door exercise from, or in consequence of, the present system of college athletics. This activity, too, has been mainly the outgrowth of the attention given to boating and to base-ball. They had the first regular organizations, and the others have taken pattern from them. It is no argument against the system that all the members of the university do not take advantage of it. The need of exercise is met, and opportunities for regular and systematic exercise are given, with inducements to take it, which do act upon at least half of the membership of the two departments most in need of it. The system might do more good if time were set apart by the various Faculties for the purpose of encouraging exercise, but in considering the system it must be borne in mind that it has grown up in a continual struggle for existence; and, until within a few years, without either help from graduates or

favor from the college authorities. But, in view of the good already done by it as a voluntary system proceeding from the students themselves, no candid man can maintain that it should be put aside without a fair consideration of its merits. In addition to those already mentioned, we claim for it the following advantages:

1. The college is sending out a better breed of men. College athletics send their healthy influence into the schools, and in them consequently increased attention is given to physical development. Thus the material coming from the schools is improved. In college this material is better preserved and better developed under the present system of athletics. More well-trained minds in more forceful bodies are graduated from college than in former years. What President Eliot says on this subject is as applicable to Yale as to Harvard: "It is agreed on all hands that the increased attention given to physical exercise and athletic sports within the past twenty-five years has been, on the whole, of great advantage to the university; that the average physique of the mass of students has been sensibly improved, the discipline of the college been made easier and more effective, the work of many zealous students been done with greater safety, and the ideal student been transformed from a stooping, weak, and sickly youth, into one well-formed, robust, and healthy."

2. The system of college athletics gives opportunity for the development of certain qualities of mind and character not all provided for in the college curriculum, but qualities nevertheless quite as essential to true success in life as ripe scholarship or literary culture. Courage, resolution, and perseverance are required in all the men who excel in athletic sports. The faculty for organization, executive power, the qualities which enable men to control and lead other men, and again those other qualities by which men yield faithful obedience to recognized authority, are all called into action in every boat-race, in every ball contest, and through all the preliminary training. In athletics the college world is a little republic of young men with authority for government delegated to presidents, captains, and commodores, and loyally supported by the resources and bodies of the governed. Is the system not worth something as a means of preparation for the responsibilities of life in the larger republic outside the campus?

3. The system is conducive to the good order of the college. It conduces to good order in furnishing occupation for the physically active. There are men in every class who seem to require some outlet for their superabundant animal life. Before the day of athletics, such men supplied the class bullies in fights between town and gown, and were busy at night in gate-stealing and in other pranks now gone out of fashion. A number of them were dissipated men, and had to diversify the monotony of their class-room life by a spree and a row. Many such men, under the present system, find occupation for all this activity in regular training. A man who goes into training can not go on sprees,

and must economize and systematize his time in order to both study and train. Having steadied their nerves by hard work of the muscles, many such men settle down to study and often make fair scholars. Any instructor who has kept track of the ways of college during the past fifteen years can not fail to be struck by the decreasing number of the really great disorders, by the mildness of those which remain, and by the increasing regard on the part of the students for college authority, college property, and for the rights of fellow-students.

The system is conducive to the good order of the college, because it furnishes a healthy, interesting topic of conversation out of study-hours. Dr. McCosh has been reported to be alarmed by the very absorbing nature of this topic of conversation. The reporter makes him say, "When one walks across the campus, the conversation he overhears bears no relation to the science and knowledge which we come here to pursue, but it is this game and that game, this record and that record." Does the gentleman suppose that, if there were no athletics, members of the college who meet one another on the campus would fall into conversation on the absorbing questions of science and knowledge? The college world is like the world in general, in that its inhabitants, when off duty, find their recreation in talking of other subjects than those of regular business. The campus is the place where the students discuss other themes than those of the class-room, for the reason that they come together on the campus for diversion. They rightly regard the study and the lecture-room as the places in which the themes of knowledge and science are properly considered. It is not to be expected, neither would it be wise nor desirable, that young men should spend all their time in thinking and talking of their studies. Since they must have something else for their leisure hours, it is well for them to have some such healthy topics of conversation as the athletic sports furnish. They naturally seek some excitement with which to vary the monotony of recitations and lectures. Their manly contests supply this want, and prevent many a man from looking to dissipation and disorder as reliefs from the daily drudgery of the study and the class-room.

Again, the system conduces to good order in its effects upon class-feeling. It acts upon this class-feeling in two ways: first, in the contests between class organizations furnishing a safety-valve for it; and, second, in the university organizations tending to moderate it. The *esprit de corps* of a class is not bad in itself. It often furnishes a motive to combined action which can be made powerful for good. In the contests between the class organizations, and in all the athletic exhibitions of the college, there are legitimate opportunities for the free play and development of this feeling. But it is possible for it to become excessive, so that a class, as a body, may have a dangerous feeling of actual enmity to another class. It is this excessive

class-feeling which is the active power in the disorders between classes. It is at this point that the influence of the university organizations acts as a check. Since these organizations are composed of men of all classes, it is impossible for all college to be enthusiastic for its crew, team, or nine, without a common sympathy binding all the classes together. Moreover, it is observable that the time of the year when the athletic contests are not absorbing the attention of the college is the very time when the disorders between classes and the persecutions of freshmen are most prevalent. Besides, the captains of the university organizations command their men to keep out of disorders, because they know that they might lose their services if these men came under the discipline of the college authorities. The writer has seen the captain of the University Foot-ball Eleven personally restraining his men from participation in a "rush." Formerly it was the strong men who incited and took the chief part in disorders. Now all their interests and all their efforts are against them.

4. The system furnishes to instructors an opportunity of meeting their pupils as men interested in a common good, without the chilling reserve of the recitation-room. It does not require a great effort to be a spectator of their contests. An interest in the contestants is a very natural result of witnessing their struggles. The college officer who gives a little of his time even to the boys' play soon finds his sympathies widen, and, by learning from actual observation how young men feel and think, becomes able to deal more wisely with those under his charge, from a fuller knowledge of them.

5. The power of the athletic contests to awaken enthusiasm ought not to be held of small account. The tendency of academic life is toward dry intellectualism. However desirable such a tendency may be for those who are training to be investigators, there can be no question that it is lamentable for a young man to begin life without enthusiasm. It is not too much to say that in many a student, while passing from freshman to the end of senior year, this spirit would die for lack of culture were it not for athletics. There is training for it in every contest witnessed. These contests affect graduates as well as undergraduates, and go far toward accounting for the warm interest which the alumni of all of the larger colleges feel in their Alma Mater.

6. The system of athletics, by its intercollegiate contests, brings the students into a wider world. They are no longer "home-keeping youths," "with homely wits." They measure themselves by other standards than those they find in the limits of their own campus.

In the next paper the writer proposes to discuss the accompanying evils of the present system of college athletics, and to present some statistics bearing upon the general subject.

STUDENTS' JAN 22 1894 ASSOCIATION

THE REMEDIES OF NATURE.

By FELIX L. OSWALD, M. D.

NERVOUS MALADIES.

HYGIENIC pathology, or the plan of curing the disorders of the human organism by the aid of the remedial agencies of Nature, is founded on the fact that disease is not only a wholly abnormal condition, but that, within the years allotted to the individuals of our species, there is a strong healthward tendency in the constitution of the human system, which tendency does not fail to assert itself as soon as the predisposing cause of the disorder has been removed. In the treatment of consumption and scrofula, the principles of this theory have been generally recognized; but I believe that their application to the nervous diseases (*asthenia*, neurosis, chlorosis, hysteria, nervous debility) is destined to effect a still greater reform in the present system of therapeutics.

The study of biology is largely a study of hereditary influences. In the form and structure, in all the peculiar life-habits of each organic being, we can trace the outcome of ancestral transmissions, and, as a general rule, the persistence of such peculiarities corresponds to the length of time during which the influence of their causes was impressed upon the character of the species. The period of artificial civilization, even if considered as coeval with the era of recorded history, is but a moment compared with the ages during which man-like creatures, the ancestors of our domestic animals and the prototypes of our cultivated plants, existed in the warmer zones of our planet. After six thousand years of cultivation on parched hill-sides, the vine is still by preference a tree-shade plant. After many thousand generations of cats have been fed and petted in daytime and neglected after dark, puss is still a night-prowler. Barn-yard fowl have still a predilection for thorny jungles, and in the plains of Russia the descendants of the mountain-goat climb wood-piles and cottage-roofs. In the constitution of all organic beings there is a tendency to revert to the original life-habits of the species. Biologists have long recognized the significance of that law, but its hygienic importance has hardly begun to be understood. For it implies not less than this: *That the vital functions of every living being are performed more easily and more vigorously under the conditions to which the constitution of its organism was originally adapted.* A swamp-boa may subsist for years in a dry board cage; eagles have been chained to a post for a quarter of a century, and lost the gloss of their feathers, their vigor, their courage, though not their lives. No drugs would cure the ailments of such captives; but restore them to their native haunts, and see how fast

they will regain their native vigor! Their infirmities could not have been traced to any single cause, but were due to the combined influence of numerous unnatural conditions.

A similar combination of abnormal circumstances causes thousands of the perplexing complaints known as *nervous diseases*—nervous debility, languor, want of vital vigor. The introduction of narcotic drinks is no sufficient explanation for the present increase of such disorders. Prince Pückler-Muskau describes an iron-fisted Arab chieftain of Southern Tunis who, in his eightieth year, could manipulate a bow that would have nonplused the champions of our archery clubs, who undertook an expedition that kept him in the saddle for three days and two nights, and who could abstain from food for the same length of time, but always traveled with a skinful of moist coffee-paste, which he sucked and chewed like tobacco. West China mountaineers, able to contest the prize of any weight-lifting match or wrestling-bout, and of otherwise most abstemious habits, can not subsist without a daily dose of the national beverage. No sensible person would maintain that such people owe their vigor to their narcotic tipples; no pathologist would deny that it deprives them of part of their strength, but that its use alone could cause the premature decrepitude of millions of Indo-Germanic invalids would be an equally untenable assertion. It is merely an additional factor in the multitude of unnatural habits that make up the misery of our modern modes of life.

That our primogenitors passed their days among trees is one of the few points on which Moses and Darwin agree; whether four handers or frugivorous two-handers, they certainly were forest-creatures, and breathed an air saturated with elements of which the atmosphere of our tenement barracks is more devoid than the briny breeze of the ocean. Our lungs suffer for it; but not our lungs alone. Besides being the best pulmonary pabulum, oxygen is a nerve-tonic; a forester, a hunter, a Swiss shepherd-boy, in a state of tubercular consumption, would be less exceptional phenomena than in a state of nervous fretfulness. A constitutional kind of good-humor sweetens the hardships of the overtaxed peasantry of Southern Europe, as its absence certainly aggravates the misery of our factory-slaves. And it would be a mistake to suppose that only summer air can exercise this nerve-soothing influence. Let a chlorotic girl take a sleigh-ride on a cold, clear winter day, or through a snow-storm; let her skate; give her a chance to get an hour's out-door exercise even on drizzly or frosty days. The north wind may white-freeze her ear-tips, but it will restore the color of her cheeks, it will restore her appetite, her energy, and her buoyant spirits. Those whom necessity compels to limit their out-door rambles to the half-mile between home and shop, should let the night make up for the shortcomings of the day, and sleep—in dry weather, at least—in the draught of a wide-open window. Only a first experiment of that sort will necessitate the addition of a night-cap to

one's bedclothing; and even nervous ladies will resist the temptation to cover up their faces, if they find how soon the wonted morning languor gives way to the influence of Nature's restorative. Those who dislike to risk the discomfort of initiation before ascertaining the value of the remedy can make another test-experiment: After a summer excursion, when fatigue and early rising enable anybody to sleep soundly in an open tent, the first few nights after returning home will be a favorable time for defying the night-air superstition and sleeping, perhaps with slight qualms of the old prejudice, but without the least bodily discomfort, on a balcony or in an open hall, with open windows on all sides. After a week, transfer the couch to the old air-tight bedroom, and note the result: All the next forenoon a queer feeling of discomfort, as after a prolonged exposure to the fumes of a smoky kitchen, will illustrate the difference between natural and unnatural modes of life. To persons who have thus emancipated themselves from the delusions of the night-air dread, the atmosphere of a close bedroom is oppressive enough to spoil the night's rest and bring on a relapse of many of the distressing concomitants of nervous insomnia. A slight elevation of the window-sash will remedy the evil, and we might expatiate upon the correlation between the nerve-centers and the respiratory apparatus of the human body, but the plain ultimate reason is that the organism has been restored to an essential element of its original existence.

Jacob Engel has a story of a splenetic student who composed his own funeral dirge, with a lugubrious list of the sorrows from which he anticipated demise would liberate his soul. On discovering the lyric, his father ordered him to excavate a gravel-bank for a family vault, as none of his relatives could be expected to survive his untimely fate. The prescription proved a success, and a few weeks later Heraclitus Junior was caught writing sonnets to the hired girl. Want of exercise is, indeed, a most fruitful cause of nervous maladies. Our Darwinian relatives, creatures so similar to us in the structure of every muscle, every joint and sinew of their bodies, are the most restless habitants of the woods. "It makes one dizzy to watch the evolutions of the long-armed gibbons," Victor Jacquemont writes from the Nerbudda; "the first one I saw made me think that he was suffering from an acute attack of St. Vitus's fits, but I have found out that it is a chronic disease. They keep moving while the sun is in sight." Savages alternate their wigwam holiday with periods of prodigious exertion, and an occasional mountain tour would atone for a good many days of city life, but hardly for weeks of sedentary occupation. Without at least one hour per day of active out-door exercise, no native strength of constitution can resist the morbific influences of stagnant humors. Of the immortal soul's dependence upon the conditions of the body there are few stranger illustrations than the psychic influence of narcotic drugs. A mere indigestion can temporarily meta-

morphose the character of the patient, and all manner of symptoms ascribed to "heart-disease," aneurism, intestinal parasites, spinal or cerebral affections, are often simply due to depraved humors and their reaction on the nervous system. By increasing the action of the circulatory system, physical exercise promotes the elimination of such humors, with their whole train of morbid consequences—chlorosis, tantrums, troubled dreams, and the nervous affections proper; restlessness and want of vital energy. What amounts of "tonic" nostrums—keeping their promise of restoring the vigor of the system by producing a *fever-energy*—would be thrown in the gutter, if the patient could be persuaded to try the receipt of Jacob Engel! "When I reflect on the immunity of hard-working people from the effects of wrong and over feeding," says Dr. Boerhaave, "I can not help thinking that most of our fashionable diseases might be cured *mechanically instead of chemically*, by climbing a bitterwood-tree, or chopping it down, if you like, rather than swallowing a decoction of its disgusting leaves." For male patients, gardening, in all its branches, is about as fashionable as the said diseases, and no liberal man would shrink from the expense of a board fence, if it would induce his drug-poisoned wife to try her hand at turf-spading, or, as a last resort, at hoeing, or even a bit of wheelbarrow-work. Lawn-tennis will not answer the occasion. There is no need of going to extremes and exhausting the little remaining strength of the patient, but without a certain amount of *fatigue* the specific fails to operate, and experience will show that labor with a practical purpose—gardening, boat-rowing, or amateur carpentering—enables people to beguile themselves into a far greater amount of hard work than the drill-master of a gymnasium could get them to undergo. Besides the potential energy that turns hardships into play-work, athletes have the further advantage of a greater disease-resisting capacity. Their constitution does not yield to every trifling accident; their nerves can stand the wear and tear of ordinary excitements; a little change in the weather does not disturb their sleep; they can digest more than other people. Any kind of exercise that tends to strengthen—not a special set of muscles, but the muscular system in general—has a proportionate influence on the general vigor of the nervous organism, and thereby on its pathological power of resistance.

For nervous children my first prescription would be—the open woods and a merry playmate; for the chlorotic affections of their elder comrades—some diverting, but withal fatiguing, form of manual labor. In the minds of too many parents there is a vague notion that rough work brutalizes the character. The truth is, that it regulates its defects: it calms the temper, it affords an outlet to things that would otherwise vent themselves in fretfulness and ugly passions. Most school-teachers know that city children are more fidgety, more irritable and mischievous than their village comrades; and the most

placid females of the genus *homo* are found among the well-fed but hard-working housewives of German Pennsylvania.

That hard work in the factory does not lead to the same result is due to the contrast between fresh and foul air; but also to the difference between sunshine and artificial twilight. Light is a chief source of vital energy, and every deduction from the proper share of that natural stimulus of the organic process is sure to tell upon the well-being of every living organism. See the difference between the vegetation of the south side and the north side of the same mountain-range, the gradations in the stunted appearance of hot-house plants, house-plants, and cellar-plants, the achromatism and strange deformities of animals inhabiting the waters of underground rivers. The direct rays of the sun seem to exercise many of the effects which the manufacturers of "electric brushes" ascribe to the use of their contrivances. In ancient Rome special sun-bathing houses were used as a specific for a form of asthenia, which was then more frequent than premature debility—the infirmity of extreme old age. In winter-time white-haired invalids, stripped to the waist, basked for hours under the glass-roof of a *solarium* which excluded the chill winds, but admitted the light from all sides, and the same remedy would prove even more effective in the treatment of chlorosis—properly a twilight-disease, and due to the same causes that rob a cellar-plant of its color and vigor. A board fence may fail to remove the fear of peeping Toms, but on sequestered mountain-meadows, warmed by a July sun, or better yet on the beach of a lonely sea-shore, the patient may while away an hour in the costume of the Nereids; or, after the manner of the sensible Brazilians, children may at safe hours be permitted to turn a leafy garden into paradise. Persons of highly limited means can utilize the elevation of their garrets, and use a half-screened window-corner as a *solarium*, for hours together. The expectation of disastrous consequences will be as surely disappointed as the dread of the night air. "Colds" are not taken in that way. The hairy coat which may, or may not, have covered the bodies of our prehistoric forefathers, did not interfere with the beneficial action of the solar rays, and it is not the least among the disadvantages of our artificial modes of life, that this benefit is now limited to one tenth, or, in the case of a muffled-up lady of fashion, to one per cent, of the cutaneous surface.

The diet should be sparing, but not to the degree of being astringent, for chronic constipation and nervousness are almost invariable concomitants. There are many appetizing vegetable articles of diet of which a liberal quantum can be eaten without exceeding the needs of the organism; but here, more than elsewhere, it is of paramount importance to remember the chief rule of the peptic catechism: not to eat till we have leisure to digest. Vertigo, myopsis (visions of floating specks clouding the eye-sight), palpitation of the heart, and the indescribable irritations and discomforts of the sufferers from

nervous disorders, can frequently be traced to the influence of after-dinner work — work, perhaps, requiring severe mental application, though the brain aches for rest—while about a million of American school-teachers and counting-house drudges still aggravate their misery by the use of tonic bitters in the United States, and of ginger-drops and *chilé colorado* in South America. Narcotic drinks are an equally fruitful source of nervous affections, and *tea*, the chief culprit, is too often mistaken for a liberator. A cup of "good, strong tea" relieves a nervous headache in exactly the same manner that medicated whiskey relieves the distress of a torpid liver, and the fact that the abnormal excitement is regularly followed by a depressing reaction would not undeceive the victim of the stimulant-delusion, if the repetition of the stimulation-process were not sure to impair the efficacy of the tonic, unless the dose is steadily increased. Only after that increase has in vain been carried to an alarming extent, the patient is apt to look for a less delusive remedy. And yet the sudden discontinuance of a long-wonted tonic will at first aggravate the distress to a degree that would overtax the endurance of most persons, and the trials of the transition period should therefore be mitigated by the influence of some healthy stimulus—the diversion of a journey, or of an exciting and very pleasant occupation. Indigestible made dishes should also be carefully avoided, and the gratitude of suffering thousands—both nurses and patients—awaits the philanthropist who shall give us a treatise on the art of preparing an appetizing dinner without the use of the frying-pan. Nervous people are extremely fastidious, especially in the choice of their solid food, and doubly so after the interdict of their favorite liquids, yet a single plateful of fried and spiced viands may bring on a relapse of the unhappiest symptoms, with the attendant mental affections of the poor followers of Epicurus who "would be perfect gentlemen if it were not for their tantrums." Spleen is a disorder of the nerves, rather than of the brain, and a large complexus of nerve-organs is situated in the close proximity of the stomach. The eel-stews of Mohammed II kept the whole empire in a state of nervous excitement, and one of the meat-pies which King Philip failed to digest caused the revolt of the Netherlands. If hired girls had a vote in the matter, ladies of a certain temper would be restricted to a diet of attractive vegetables.

Everything that tends to exhaust the vital resources of the body disposes it to nervous disorders. *Sexual excesses*, therefore, contribute a large share to the debilitating influences of civilized life. Hysterical affections may sometimes result from the unsatisfied cravings of the sexual passion, but chiefly because the suppression of that instinct often leads to its perversion. There is such a thing as mental incontinence; the writings of hysterical nuns, for instance, abound with erotic effusions. And, while spinsters and widows are often strong-minded to an unsexing degree, the most pitifully nervous women are

found among the wives of the wretches who consider a marriage-contract a license for illimited venery. For girls of a chlorotic disposition, a prurient literature does what sewer-gas would do for a consumptive—though idleness will find other means to supply the want of dime-novels. In such cases, *out-door work* is worth all the medicines of the drug-market.

A quiet country home is the best refuge from the sufferings of that dreary form of nervous disorders that result from the reaction of deep mental wounds—disappointed hope, reverses of fortune, or the loss of a favorite child. Seasons make no difference; the very hardships of rustic life often act as a balm in such afflictions. After the death of his only son, Goethe sought solace among the pines of the Thuringian forest, like Shenstone in his Ainsford solitude, and Petrarch in his hermitage of Vaucluse. "A sick man," says old Burton, "sits upon a green bank, and, when the dog-star parcheth the plains and dries up the rivers, he lies in a shady bower, *fronde sub arborea ferventia temperat astra*, and feeds his eyes with a variety of objects, herbs, trees, to comfort his misery—or takes a boat on a pleasant evening, and rows upon the waters, which Plutarch so much applauds, Ælian admires, upon the river Pineus—in those Thessalian fields, beset with green bays, where birds so sweetly sing that passengers, enchanted, as it were, with their heavenly music, *omnium laborum et curarum obliviscantur*, forget forthwith all labors, care, and grief." Especially if the passenger can be persuaded to row his own boat, and to dismiss the delusion that the night-mists of his Pineus have to be counteracted with a bottle of alcoholic bitters.

In the homes of the poor, nervous afflictions are sometimes the result of *insufficient sleep*. After a sleepless night, the attempt to engage in labor of an exacting kind will lead to a fever of fidgets and nervous twitchings, and the same consequences may result from the habit of rising every morning before Nature admits that the gain of the night has quite equalized the expenses of the foregoing day. But it is a true saying that we are not nourished by what we eat, but by what we digest, and that an indigestible meal is as bad as a fast-day. Nervous people should remember that unquiet sleep is not much better than sleeplessness, and that the blessing of a good night's rest can be enjoyed only in a well-ventilated bedroom. With the largest possible supply of fresh air by day and by night, with sunshine, out-door exercise, and healthy food, the most obstinate nervous disorders can be gradually overcome; the impediments yield, till the river of life flows with an unobstructed current: the body has been restored to the conditions of existence for which its organism was originally adapted.

DANGEROUS KEROSENE AND THE METHODS FOR ITS DETECTION.

By Dr. JOHN T. STODDARD,
PROFESSOR OF CHEMISTRY IN SMITH COLLEGE.

KEROSENE, in virtue of its cheapness and the brilliant light it gives, has found its way into almost every house. And yet frequent and often horrible accidents prove that much of the oil now sold is of a most dangerous character. It is the recognized duty of the State to render the sale of such oil impossible by proper inspection. Almost daily reports of loss of property and life, as the result of the use of unsafe kerosene, show, however, that this official control fails to effect its object. This may be due, in a measure, to the undoubted negligence of cities and towns to appoint competent inspectors—if, indeed, any appointment is made—or to the carelessness of the inspectors; but of greater importance even than this are the low standards adopted, and the unreliability of the tests which are used to determine the character of the oil.

It is the object of this paper to consider the conditions of safety in an oil used for illuminating and heating purposes, and to give a brief sketch of the principal methods which have been proposed for determining this important point.

Petroleum, from which kerosene is prepared, is, as is generally known, a mixture of a large number of intimately related compounds of widely differing volatility. Some are gaseous, and escape in this form as the petroleum issues from the ground, while others form the solid paraffine. The middle portions of the crude oil are separated from the more and less volatile compounds by distillation, and after a further process of purification go into the market as kerosene. The entire removal of the lighter and more volatile portions, which are known as naphtha and benzine, is of the utmost importance, for it is in their presence that the danger lies. Alone, they are easily ignited, and alone or mixed even in small proportion with kerosene, they readily emit vapors which are inflammable and which with air form an explosive mixture.

An oil is safe only when it will not yield these dangerous vapors at any temperature which it is liable to assume. This temperature depends obviously (1) upon that of the place where the oil is kept or used, and (2) upon the influence of the heat of the burning wick in warming the oil in the reservoir of the lamp. As the result of carefully conducted experiments with lamps of different patterns, it has been found* that the maximum increase of temperature of the oil

* "Zeitschrift für anal. Chem.," xxi, 332.

in a burning lamp is some 16° Fahr. (9° C.). Before the lamp is lighted the oil in it will in most cases have the temperature of the air about it. Our rooms in summer often have a temperature of 90° Fahr., and reach 100° Fahr. in a few exceptional days, while in winter the oil assumes even a higher temperature than this when the lamp is placed—as it often is—near a stove or an open fire.

Hence, it is plain that the lowest temperature at which an oil may evolve inflammable vapors and be considered safe must be put at 116° Fahr., or better still at 120° Fahr.

What, now, are the means for determining the temperature at which these vapors appear, and thus for deciding upon the safety or danger of an oil? It seems at first thought a simple and certain matter. Put a little oil in a cup and suspend a thermometer in it; warm it slowly, and, as the temperature rises from degree to degree, pass a lighted match just above its surface. Presently the match will cause a tiny explosion. This indicates that the dangerous vapors are appearing, and the thermometer now gives the so-called *flashing-point* of this oil. Go on heating and testing as before, and at last the oil will take fire and continue burning by itself. The mercury is now at the *burning-point*. But repeat the experiment with fresh samples of the same oil, and you will find that a trifling variation in the conditions will alter the flashing-point to a wonderful extent. The quantity of oil used for the test, the rate of heating, and the range of temperature through which the oil is heated, the distance above the surface at which the match passes—each and all have a marked influence on the determination.

The *burning-point*—or *fire-test*, as it is often misleadingly called—is of little value; for not only does it always lie above the flashing-point—which is the real danger-point—but it bears no simple relation to the latter, so that its determination gives really no clew to the temperature at which the oil becomes unsafe.

The unreliability of this simple method of testing and the importance of the problem have called forth numerous suggestions for improvement. Within the last fifteen years no fewer than twenty-five different instruments have been proposed, presenting as many more or less widely modified forms of the simple cup-tester indicated above. The most essential variations are (1) in the size and form of the oil-holder or cup, which in some apparatus is open, in others partly or wholly closed; (2) in the dimensions of the water-bath—which is invariably employed in all as the best means for communicating a slow and uniform increase of temperature to the oil; (3) in the means used for igniting the vapor—a burning match, waxed thread, small gas-jet, electric spark, or little oil-lamp standing on the cover of the oil-cup being the chief devices for this purpose.

But, notwithstanding all the ingenuity displayed, and the elaborate and costly apparatus to which it has in some instances given birth, we

find Engler and Haass,* at the close of a careful investigation into the reliability of petroleum-testers, in which all the more promising methods were laboriously examined and compared, laying down these general principles, which are to be observed in the construction and use of this class of testers:

1. The quantity of oil must be the same in all experiments.—In the Saybolt tester, for instance, which was adopted in 1879 by the New York Produce Exchange (chiefly, however, for the purpose of determining the burning-point), variations of one millimetre, or about one twenty-fifth of an inch, in the height of the oil, cause differences of some degrees in the flashing-point.

2. The oil must be heated slowly and uniformly.

3. The temperature of the oil at the beginning of the test must be at least 18° Fahr. (10° C.) below its flashing-point (which is approximately determined by a preliminary test). Hence, a low-grade oil, which flashes not far from the air temperature, must be cooled down before an accurate determination can be made.

4. The size and intensity of the flame or spark used to produce the flash must remain unchanged in all tests. Increase in size or intensity lowers the flashing-point.

5. The distance of the flash-flame or spark from the surface of the oil must be the same in all tests. The flashing-point is lowered by decreasing this distance. Care must be taken that this distance is not so small that a local evolution of vapor from the surface occurs.

6. The time during which the flame or spark acts must be reduced to a minimum, increase in the time causing a sensible lowering of the flashing-point.

7. On account of the practical purpose for which the tests are made, the conditions under which the vapor is formed in the tester should correspond as closely as possible to those which determine its formation and explosion in lamps, etc.

Comment upon methods which depend for trustworthy results upon such a formidable array of conditions is hardly necessary; the best apparatus must be electrical and costly, and even then unreliable except in the hands of an expert. We are not surprised to find Mr. A. H. Elliott, in his report of a similar investigation ordered by the New York State Board of Health, giving as his general conclusion: "Of all the apparatus examined, not one can be called perfectly satisfactory. . . . Of the electric testers it may be stated, that any advantage obtained from the use of electricity is more than overcome by the trouble necessary to maintain the galvanic battery and induction-coil." But, even if the performance of some of these instruments is such as to yield concordant results, when all the precautions are carefully heeded, these results can have only a *relative* significance, and agreement of different testers can only be secured by

* "Zeitschrift für anal. Chem.," xx, 1.

selecting one with its manipulation as an arbitrary standard, and adopting conditions in the others which shall give corresponding results. Nor can it be affirmed that all the conditions under which explosions in lamps are liable to occur are provided for in any single instrument

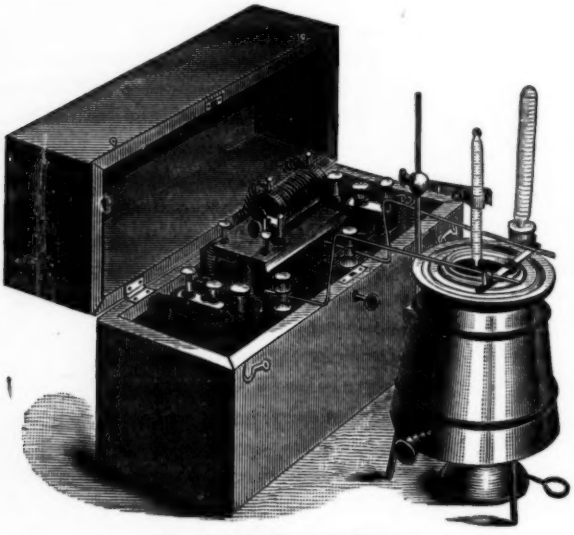

FIG. 1.—THE SAYBOLT TESTER.

of this class. The oil-reservoirs of our lamps differ much in size and shape, and hence have different capacities. Moreover, the quantity of oil, its surface, and the amount of air in the reservoir with which the vapor mingles, are constantly changing while the lamp is in use and the danger greatest. Again, it is not alone in quietly burning lamps that accidents occur. Probably half are due to upsetting or breaking, and the oil, which would have been safe otherwise, gives rise to explosion or flames under these more dangerous circumstances.

If it is important to test the oil, it certainly is wise to employ, if possible, a test which shall indicate the lowest temperature at which, under *any conditions*, inflammable vapors can be evolved, and not to trust to a method which merely proves an oil safe under certain arbitrary conditions.

Besides these instruments which aim at a direct determination of the temperature at which an oil becomes dangerous, others have been proposed in which the character of the oil is tested in an indirect manner, by finding the elastic force or tension of its vapor at a given temperature. The tension is measured by the height of the column of water which it sustains. By comparing the tension which any oil gives in this apparatus with that of some kerosene which has been selected as a standard, the quality of the former is ascertained—a higher tension indicating a more dangerous oil. It is plain that the reliabil-

ity of this method depends upon the assumption that a definite relation exists between vapor-tension and flashing-point in all kerosenes. It has, however, been shown in the most conclusive manner, that this is not the case.* Four different oils, which all had a flashing-point of 28·5° to 29·5° C., as determined by one of the most trustworthy of the testers before described, were found to give, at 28° C., vapor-tensions of 75, 104, 118, and 168 millimetres (of water); and, at 40° C., tensions of 126, 149, 165, and 201 millimetres. Further, seven different kerosenes gave, when tested by the two methods, the following results:

OIL.	1.	2.	3.	4.	5.	6.	7.
Flashing-point....	25° C.	26° C.	26° C.	28° C.	30° C.	44° C.	48° C.
Tension at 35° C..	95mm.	160mm.	201mm.	73mm.	45mm.	13mm.	5mm.

It thus appears that the results obtained by the measurement of the vapor-tension are quite worthless as indications of the dangerous character of kerosene, and the method must be regarded as far less reliable than even the imperfect ways of testing which have been already discussed.

The uncertainties of the foregoing methods are entirely avoided by a *distillation test*, which also enables one to decide the quality of the oil as an illuminating material, and thus gives the fullest information in regard to its nature.† The oil is separated by the distillation into three fractions: a light oil distilling below 150° C.; illuminating oil coming over between 150° and 270° C.; and a heavy oil which boils above 270° C. The first fractional distillate represents the dangerous constituents, and should not exceed, according to Bielstein, five per cent of the whole. The heavy oil affects the freedom with which the kerosene burns in a lamp, and, in American kerosene, should not form more than fifteen per cent of the oil. The operation must be conducted with care, in a flask provided with a dephlegmator, and the fractions, as well as the original sample, must be weighed. These circumstances are likely to prevent the general adoption of a method which is otherwise so simple and satisfactory, and kerosene will probably be tested in the future, as now, by the determination of its flashing-point.

In 1879 Victor Meyer‡ suggested a principle by which the minimum, or, as he called it, "true or absolute" flashing-point, could be determined. It is to *saturate air with oil-vapor* at the test-temperature. His method is simply this: A glass cylinder of about 200 c. c. capacity is partly filled with oil, stoppered with a cork through which a ther-

* Engler and Haasa, *loc. cit.* † "Zeitschrift für anal. Chem.," xxii, 318.
‡ Wagner's "Jahresbericht," 1879, 1175.

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mometer passes, and heated by plunging into warm water; when the temperature is reached at which the test is to be made, the cylinder is briskly shaken, the stopper removed, and a small flame introduced. Flashing-points obtained by this plan are considerably lower than those given by the methods which have been discussed, and are found, moreover, to be largely independent of the conditions so essential to success in the latter.

Haass * has described an elaborate and clever apparatus based on the same principle, and differing essentially from Meyer's only in the substitution of an electric spark, at a fixed distance from the surface of the oil, for the flame which the latter employed. In both of these methods the flashing-point depends upon the time allowed between the shaking and testing, Haass recommending an interval of one minute after the bubbles have disappeared from the surface of the oil, in order to permit the suspended oil-particles to settle. The shaking, which must be repeated from degree to degree, is a troublesome feature of these methods, and, though Meyer's apparatus is certainly simple and inexpensive enough, that of Haass is difficult of construction, electrical, and costly. The general principle of these methods is, however, without question the correct one for obtaining a minimum (and approximately "absolute") flashing-point, and it is to L. Liebermann † that we owe the suggestion of an ingenious and successful plan for

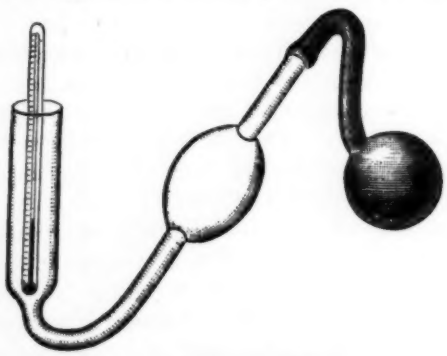


FIG. 2.—LIEBERMANN'S TESTER.

avoiding the difficulties mentioned above. In Liebermann's method the saturation of air with vapor is accomplished by forcing an air-current through the oil as it is warmed from degree to degree; and the test made by bringing a small flame to the mouth of the oil-holder at the same instant.

It has, however, been shown that the intermittent current of air which is recommended gives somewhat irregular results, and that more concordant flashing-points are obtained by letting a continuous current

* "Chem. Industrie," 1880, 123, and "Zeitschrift für anal. Chem.," xx, 29.

† "Zeitschrift für anal. Chem.," xxi, 321.

run through the oil for at least one minute before the flash occurs. It may perhaps seem, at first thought, that a continuous current of air would dilute the vapor to such an extent that the flashing-point must be materially raised, and that this effect must be more marked as the velocity of the current is increased. This is, however, not the case. On the contrary, while a *slow*, continuous current raises the flashing-point appreciably, a sufficiently *rapid* one gives nearly the same results as the intermittent method ; nor does any further increase in the velocity alter the flashing-point to a sensible extent. It has indeed been found that a large dilution of kerosene-vapor with air is necessary to furnish the conditions for the most violent explosion ; and these conditions are also those for the readiest flash by this method of testing. The most explosive mixture, according to Chandler, is formed by nine parts of air to one of vapor. The passage of a large quantity of air through the oil tends, of course, to make the flashing-point higher, by carrying away with it the more volatile portions which determine the flash, and this effect is greater when the quantity of oil is small and the air-current long continued. It is, consequently, necessary in the employment of this method to know the minimum quantity of oil and the maximum duration of air-current which will permit concordant results. These limits have been ascertained in a recent investigation,* the results or which are given a little further on.

A tester of still simpler construction than that of Liebermann has also been proposed.† It consists, as shown in the cut, of a glass cylinder, closed at one end by a cork, through which a small bent tube, *d*, *c*, *b*, passes. Just within the cork the end of this tube contracts to a small orifice. The other end of the tube connects with a small bellows, or other source of slightly compressed air, the flow of which can be regulated by the pinch-cock *e*.

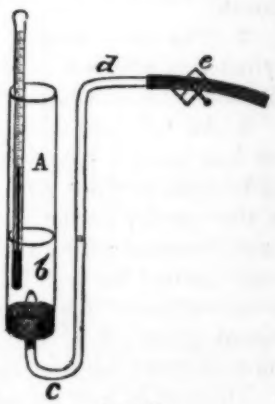


FIG. 3.

Experiments made with cylinders of different dimensions have shown that the best results are obtained when the diameter is between 2·5 and 4 c. m. The length (if only great enough to allow at least the minimum quantity of oil to be used) makes no difference. Cylinders of the same diameter but of different lengths, when filled with oil to within the same distance from the top, all give the same flashing-point. Change in length in such cases is simply equivalent to change in the quantity of oil employed in the test, and it has been proved that the quantity of oil does not affect the determination when it is above a certain minimum.

* "American Chemical Journal," vi, No 1.

† Ibid., iv, No. 4, 285, and "Ber. d. Deutschen chem. Gesell.," xv, 2555.

The distance of the oil, or rather of the foam into which the surface is broken by the air-current, from the top of the cylinder, however, makes a considerable difference in the results—the flashing-point falling as this distance is decreased, until at about 5 to 6 c. m. it reaches a minimum.

These considerations lead to the following statements and directions for the use of this method:

1. The oil-cylinder should have a diameter of 2·5 to 4 c. m. It may be of any convenient length, provided it holds, when filled, for the test not less than 50 c. c. of oil. With a diameter of 2·5 c. m., the length should be at least 16 c. m.; with a diameter of 3 c. m., the least length should be 13 c. m. A good tester may be made from the chimney of a student-lamp, by cutting off the lower part, a little above the contraction. (Glass is easily cut by filing a deep notch at one point, and letting a little gas-flame play slowly back and forth across it in the line of the proposed section, until a crack springs quite through the glass; this crack can then be led in any desired direction by keeping the little flame just ahead of it on the glass.) The whole chimney may also serve as an oil-cylinder by corking the large end. The irregularity of shape at the bottom does not affect the results; but the length makes it rather inconvenient by requiring a correspondingly deep water-bath.

2. The cylinder is filled with oil to a point such that, when the air-current is running, the top of the foam is 4 or 6 c. m. below the mouth.

3. The oil is heated by means of a water-bath, into which the cylinder is plunged to the level of the oil. The temperature of the oil should not rise faster than two degrees a minute.

4. Air is forced through the oil with such velocity that about (and not less than) 1 c. m. foam is maintained on the surface, and a flash-jet brought to the mouth of the cylinder every half degree, or oftener in the vicinity of the flashing-point. The approach of the flashing-point is announced by the appearance of a faint blue halo of burning vapor around the flash-jet; this finally detaches itself and runs down to the surface of the oil, and the reading of the thermometer at this instant gives a trial flashing-point, which may be a little too high if the air-current has been running too long, or not long enough.

The test is now repeated with a fresh sample of the oil, and the air-current started in full strength not less than one nor more than three or four minutes before the flash occurs. It is a good plan, however, to let a very slow current of air bubble through the oil from the time that the tester is put in the water-bath, so as to secure regularity in the heating of the oil.

A very good flash-jet is a little gas-flame from the tip of a blow-pipe, or glass tube drawn out to a point.

The advantages of this method are:

1. Simplicity of apparatus. It can be made in a few moments by any one who can bend a glass tube.

2. Simplicity of manipulation. A manufacturer, asked to try it, obtained concordant and accurate results at the first trial.

3. Trustworthiness of the results, which are independent of arbitrary conditions, and have a significance wholly wanting in methods based upon other principles. The flashing-point determined is the *lowest*.

The lowest flashing-point for illuminating oils in New York is fixed by law at 100° Fahr., and this is as determined by a modification of the Wisconsin tester, an instrument which demands all the precautions so emphatically given by Engler and Haass. In Massachusetts, method and flashing-point are apparently both left to the wisdom and discretion of the inspector.

And yet we have seen that 116° Fahr. is the very lowest flashing-point consistent with safety, and this should mean the *minimum* flashing-point determined by some fully reliable method. We must not be misled in this matter by the statement that our best kerosenes are "150° or 160° test" oils; for this has reference, not to the flashing-point, but to the fire-test, or burning-point, which, as has already been shown, gives little indication of the character of an oil. The best oils sold *flash* at about 109° Fahr., while the cheaper grades have much lower flashing-points—at least as low as 85° Fahr.

We need not be surprised, then, at the numerous accidents; they will not diminish until a much more efficient and intelligent system of inspection is enforced than now. We are far too much inclined to take our risk, even in the midst of constant warnings; we leave our kerosene to the ignorant and careless handling of our servants; we buy, perhaps, a cheaper grade from motives of economy, only to find that the oil in which we thoughtlessly trusted has occasioned loss of property, horrible suffering, or even death.

As long as unsafe kerosene is offered for sale, we may be sure purchasers will be found. The only safe way is to banish the dangerous stuff from the market.

THE MORALITY OF HAPPINESS.

By THOMAS FOSTER.

IV.—RIGHT AND WRONG.

IN its scientific aspect, then, as indicated by processes of evolution, conduct is good in proportion as it tends to increase the quantity and the fullness of life, bad in proportion as it exerts a contrary influence. Conduct may tend to increase life in its fullness directly or indirectly, proximately or remotely; and again conduct may in one

aspect increase, while in another aspect it may diminish, the fullness and quantity of life: but our definition of good and bad conduct is not affected by such considerations. Just as a knife may be a good knife for cutting bread, and a bad knife for cutting wood, just as a business transaction may be good in relation to some immediate purpose, yet bad when remoter effects are considered, so can we truly apply to conduct the terms *good* and *bad* in reference to one set of considerations, even though we may have to invert the terms when conduct is considered in reference to another set of considerations. But always, in its scientific aspect, conduct is to be regarded as good where it increases life or the fullness of life, and bad where it tends the contrary way.

When we separate conduct ethically indifferent from conduct in its strict ethical aspect, it is convenient to substitute for the words *good* and *bad* the words *right* and *wrong*. But the change is slighter than at first sight it appears. Indeed, the more carefully the question of rightness or wrongness—the question of *duty*—is considered, the more thoroughly does the kind of conduct judged to be morally indifferent merge into that which we regard as praiseworthy or censurable.

Taking first those parts of conduct which relate directly to the quantity or to the fullness of individual life, we find that while the terms good and bad are freely applied to them, and even the terms right and wrong, they are, for the most part, regarded as morally indifferent. When we say you *ought* to do this or to refrain from that, the idea of duty is often not really present, so long as the act in question relates to a man's own life or its fullness. Even when we use words of praise or censure in relation to such acts, they do not imply that a moral obligation has been discharged or neglected. The reason doubtless is that, as a rule, men need little encouragement to look after those parts of their conduct which affect themselves and their own interests. For it may be observed that where it is likely there may be want of due care or wisdom in such matters, there we find distinct exceptions to the general rule just indicated. So far as quantity and fullness of life are concerned, the man who crosses a crowded thoroughfare carelessly, he who neglects his business, and he who wears insufficient or unsuitable clothes in cold and wet weather, act with as little propriety in their adjustments as is shown by the man who steadily drinks intoxicating liquors. But while none preach such duties as caution in street-crossing, prudence and energy in business, and care about clothing, at least as duties morally obligatory, quite a number of persons preach against steady and heavy drinking as against a moral offense. The Bible, indeed, does not, though it has many a word of advice against wine-bibbing; yet even in the Bible we find evidence of the early existence of total abstainers, and it is altogether unlikely that those ancient Blue-Ribbonists omitted to recog-

nize sinfulness in all who did not share their views and follow their practices. Here we find evidence of the law of moral philosophy that a system of ethics, with recognition of moral rightness and wrongness, only begins to be formed where the best conduct (so far as fullness of life is concerned) runs the chance, for whatever reason, of being neglected, and inferior conduct followed. In this case, the best conduct is apt to be neglected because the increased fullness of life to which it conduces is more remote than the temporary increase of life fullness to which inferior conduct tends.

Yet, speaking generally, it may be said that, as Mr. Herbert Spencer puts it: "The ethical judgments we pass on self-regarding acts are ordinarily little emphasized; partly because the promptings of the self-regarding desires, generally strong enough, do not need moral enforcement, and partly because the promptings of the other self-regarding desires, less strong, and often overridden, do need moral enforcement."

When we turn to the life-regarding actions of the second class, those which relate to the rearing of offspring, we no longer find the words good and bad, right and wrong, used with doubtful meaning. Here the question of duty is clearly recognized. The conduct of parents, who, by neglecting to provide for their children's wants in infancy, diminish their chances of full and active life, or of life itself, is called bad and wrong not solely or chiefly because it is not favorable to the increase of life, but as open to moral censure. In like manner, men blame as really wrong, not merely unwise or ill-adjusted, such conduct as tends to make the physical and mental training of children imperfect or inadequate.

Still clearer, however, is the use of the words right and wrong as applied to conduct by which men influence in various ways the lives of their fellows. Here the adjustments suitable for increasing the fullness of individual life, or for fostering the lives of offspring (alike in quantity and fullness), are often inconsistent with the corresponding adjustments of others. The development by evolution of conduct tending to the advancement of individual lives or lives of offspring would of itself tend constantly to acts inconsistent with the well-being or even with the existence of others, were it not for the development (also brought about, as we have seen, by processes of evolution) of conduct tending to the increase of the quantity and fullness of life in the community. But there arises a constant conflict between tendencies to opposite lines of conduct. It is so essential for the welfare of the community that tendencies to advance the life interests of self and children should be in due subordination (which is not the same thing, be it noticed, as complete subordination) to tendencies leading to the furtherance of the fullness of life in others, that rules of conduct toward others than self or children have to be emphatic and peremptory in tone. Hence it is, as Mr. Spencer justly remarks, that the

words good and bad have come to be specially associated with acts which (respectively) *further* the complete living of others and acts which *obstruct* their complete living.

We approach now the heart of the matter. We have seen how conduct has been evolved in the various races of living creatures, from the lowest to man the highest. We have learned how closely related are men's ideas of good and bad to that which is the chief end of all conduct—the preservation and extension of life. And we have found that while the conception of rightness and wrongness is not very marked in relation to conduct affecting self-life, it becomes clear and obvious in relation to conduct affecting the life of offspring, and attains its greatest definiteness and as it were emphasis in its application to conduct affecting the lives of others. Where the rules determining right and wrong in regard to the life of self, of offspring, and of others, come into conflict, as they must until social relations become perfect, the right in regard to self mostly gives way to right in regard to offspring, and both usually give way to right in regard to the rest of humankind. But in Mr. Spencer's words (I quote them with emphasis, because he has been so preposterously and indeed wickedly charged with teaching a very different doctrine) "the conduct called good rises to the conduct conceived as best, when it fulfills all three classes of ends at the same time."

But now the vital question of all comes before us.

We conceive as good or bad such conduct as conduces or the reverse to life and the fullness of life, in self and others. But is conduct of the one kind really good or conduct of the other kind really bad? Though good or bad with reference to that particular end, and though held to be right or wrong because that end is actually in view among men, may not conduct be differently judged when the nature of that end is considered? In other words, the question comes before us, Is life worth living? We need not take either the optimist view, according to which life is very good, or the pessimist view, according to which it is very bad. But each one of us from his experience as regards his own life, and from his observation (often most misleading, however) on the lives of others, may be led to hold that on the whole life is good, or that on the whole it is bad. Of course, in the very theory of the evolution of conduct, or rather in the series of observed facts demonstrating the evolution of conduct, we see that life and the fullness of life are fought for throughout nature as if they were good. In the highest race the love of life in self, which assumes that the life of others also is good, has attained its highest expression. "Everything that a man has he will give for his life," is a rule established rather than shaken by exceptions and the attention directed to such exceptions. Yet the mere fact that life is fought for by all, and that the struggle for life has been so potent a factor in the development of life, does not in itself prove life to be an actual good. Death comes

not alone. To creatures full of life death comes in company with pain and suffering. It may be these which move all living creatures to struggle for life, and not mere fear of death.

Now, to the question, Is life worth living? it would be impossible to give an answer that would suit all. Probably there have not been two human beings since the world was made who, could they express their precise opinion on this point, would give precisely the same answer. Many whose whole lives have been full of sorrow and trouble, who have had occasion many times to say that man was born to sorrow, would yet, even taking survey of their own sad lives, say—life is sweet. That many whose own lives have been bitter enough, think yet that life is sweet, is shown by this, that among them have been found those who have done most to foster the lives of others. But many of them would say that life is sweet, speaking even from their own experience of life. And on the other hand many who are held by those around them to have had little sorrow, who from childhood to old age have scarce ever known pain or suffering, who have had more than their fill of the pleasures of life, and have escaped the usual share of life's afflictions, would speak of life as dull and dreary if not bitter. It has been indeed from such men that the doubting cry has come, Is life worth living? Men of more varied experience would give other answers to that vain question. All answers, indeed, must be as idle as the question itself. Yet most men would give the answer which says most for the pleasantness of life—that, as a whole, life is neither bitter nor sweet, neither sharp nor cloying, but that it "has all the charm in bitter-sweetness found."

We are not concerned, however, to inquire what is the true answer to the question, Is life worth living? Though it is clear that if life is not worth living the observed action of evolution has been unfortunate, and the resulting laws of conduct are a mistake, while the reverse must be held if on the whole life is well worth living, yet, so far as our subject of inquiry is concerned, it matters not which view we take. That which is common to both views is all we have to consider. The man who holds that life is worth living, so thinks because he believes that the pleasures of life on the whole outweigh its pains and sorrows. The man who holds that life is not worth living does so because he thinks that the pains and sorrows of life outweigh its pleasures. So much is true independently of all ideas as to what are the real pleasures or the real pains of life, or whether life here is most to be considered or chiefly a future life with pleasures or pains far greater in intensity and in duration than any known here.

Where or what the chief pleasures or pains of life may be, when or how long endured, in no sort affects the conclusion that life is to be considered worth living or the reverse according as happiness outvies misery or misery happiness, and that therefore the rightness or wrongness of conduct must be judged not by its direct action on life and the

fullness of life but by its indirect influence in increasing or diminishing the totality of happiness. To quote again the words of the great teacher who is so often misquoted and so much misunderstood:

"There is no escape from the admission that in calling good the conduct which subserves life, and bad the conduct which hinders or destroys it, and in so implying that life is a blessing and not a curse, we are inevitably asserting that conduct is good or bad according as its *total** effects are pleasurable or painful."—*Knowledge.*

THE AURORA BOREALIS.

By M. ANTOINE De SAPORTA.

HOW can we describe, how can an artist paint, the aurora borealis? We of temperate climates are not strangers to the phenomena; we know something of the arcs and radiating streaks of various-colored light which frequently adorn our northern skies; and we are occasionally permitted to witness exhibitions in which the whole heavens shine with their marvelous glow. Yet travelers from the far North say that we can have no conception of the wonderful splendor of the phenomena as witnessed within the Polar Circle, and that nothing but the actual sight can convey an adequate idea of it.

The aurora borealis was well known to the ancients. The Greeks, discovering graceful symbols in everything, thought it was the glory of the Olympian gods holding council in a sky illuminated for the occasion. The Romans, on the other hand, always looking for unlucky omens, were in dread of it. Pliny, following Aristotle and Seneca, speaks of celestial fires that tinged the sky with a blood-red, of beams of light, of openings yawning in the starry vault, of fantastic lights that changed night into day; and he took care not to omit the political events that accompanied such manifestations, without, however, affirming that the phenomena were the cause of the catastrophes that attended or followed them.

* I have ventured to emphasize this word (though the emphasis is not necessary for the ordinarily attentive), simply because so many have either actually misunderstood Mr. Spencer's saying here, or else have pretended to do so. The word emphasized makes the saying not only true, but (as it was intended to be) obviously true. Mr. Spencer is here purposely stating a truism, or what ought to be a truism. No matter what a man's doctrine in religious matters may be, no matter what his views as to a future state, the saying above quoted is absolutely true. It is true in small matters as well as in great. By overlooking the word "total," or by treating the saying as though for the word "total" the word "immediate" might honestly be substituted, the saying expresses what Carlyle contemptuously called pig-philosophy; but Spencer's actual saying is about as remote from pig-philosophy as any teaching well could be. It inculcates a philosophy more truly regardful of self than the sheerest egoism, more justly and beneficently regardful of others than the purest altruism.

At troubled seasons in antiquity and the middle ages, in times of war, famine, or epidemic, the only sentiment the aurora excited was that of fear, and the people thought they could see in the sky rivers of blood, armies clashing, and infantry and cavalry engaging in mysterious combats. Now, except among a few superstitious or uninformed persons, the phenomena are witnessed with simple curiosity by some, with indifference by others.

A thousand years after Gregory of Tours, who gave the meteor the name it now bears, Gassendi first examined it with a scientific eye, and definitively baptized it on the 12th of September, 1621. The terms "polar light" and "northern light," which have been proposed by various physicists, have never prevailed; the bishop and the philosopher have triumphed. From the beginning of the eighteenth century, observations became more numerous, and theories and scientific discussions began to appear. The subject even tempted the poets. To say nothing of the Abbé Delille, an Italian Jesuit, Father Noceti, sung the aurora in Latin verse. Frazier, in 1712, first witnessed a southern aurora.

It is affirmed that the aurora was not common in Scandinavia and Holland previous to about 1716, after which it began to appear more frequently. Whether this be so or not, the attention of several Swedish, Dutch, and French investigators was fixed upon it. Celsius, the designer of the centigrade thermometer, remarked the curious distractions to which compass-needles were occasionally subject, without visible cause; studying the perturbations more closely, he had no difficulty in assuring himself (1741) that they coincided with the appearance of the aurora borealis. Hjorter, another Swede, made the same observation at about the same time.

The question whether auroras are of cosmic origin, or whether they proceed from purely terrestrial influences, which still provokes discussion, has from the beginning divided the learned into two parties. Mairan maintained the extra-terrestrial character of the meteor, while the contrary opinion found a supporter in Musschenbroek, the inventor of the Leyden-jar.

Musschenbroek, still evidently under the influence of old middle-age prejudices, gave out the following hypothesis: Near both poles, and at a little distance beneath the surface of the globe, are immense reservoirs of phosphorescent matter. Whenever a fissure is formed reaching to them, the substances, readily volatile, escape and illuminate the atmosphere with their glow. The frequency of auroras in particular years was explained by supposing a subterranean cavern to have been opened. When the pocket was exhausted, the phenomenon would of course be at an end for some time. So, after the exhaustion of the provisions of phosphorescent stuff accumulated in a particular region, the meteors would necessarily cease to show themselves, not to appear again till after a long time, during which the matter would ac-

cumulate again. It was thought that years of dry weather were years of maxima of auroras, and it seemed natural to suppose that moisture would hinder exhalations. Extensive efforts were made, without success, by studying the properties of the recently discovered phosphorescent substances, to determine the nature of the stuff that thus shone in space. Previous to this, an explanation of the phenomenon had been suggested by supposing a fermentation of gross exhalations from the earth's surface which were driven toward the pole and there took fire.

Quite different from this was Mairan's theory ; and the reading of his book, "Traité physique et historique de l'aurore boréale" ("A Physical and Historical Treatise on the Aurora Borealis"), which appeared in 1733, is still indispensable, after a hundred and fifty years, to any person wishing to study the meteor to-day. Rejecting the ideas outlined above, and another curious hypothesis, that the rays of the sun were reflected from the polar ice, and sent back to the observer from the concave surface of the upper strata of the atmosphere, he had recourse to the zodiacal light which had been observed by Cassini some fifty years before. While some explained this phenomenon by supposing a ring of light concentric with the sun, and surrounding it without touching it, others, and Mairan among the number, considered it a prolongation of the solar atmosphere, accumulated chiefly in the plane of the ecliptic or of the solar equator, and extending beyond the orbit of Venus. Emanations from the sun, or rather the corona that surrounds it, according to Mairan, strike our atmosphere and illuminate our globe. Then, must we suppose that the zodiacal light shines of itself ? That is not necessary, says Mairan. A chemical combination, an essentially luminous precipitate, results from the mixture that takes place in the upper regions of the atmosphere.* This supposition is hazardous, and Mairan seems to be a little too fast. It is, however, indisputable that then, as now, auroras were more frequent in March and September, or the months when the zodiacal light is brightest. It is also worthy of remark that Angström, in 1867, and Respighi, in 1872, found in the spectrum of the zodiacal light a green ray identical with a line of the same color characteristic of the aurora borealis.

Mairan found a redoubtable antagonist in the celebrated mathematician Euler, who did not admit the hypothesis of an immense solar atmosphere, and believed only in the existence of a ring. He invented, in explanation of the meteor, a somewhat obscure theory, according to which the subtile and rarefied portions of the air were driven away from the surface of the globe, and the particles, having become lumi-

* Mairan observes that, the centrifugal force being less toward the poles than at the equator, the parts of the globe at the tropics will repel the foreign matter, and it will accumulate toward the high latitudes. Hence there will be few auroras except in the frigid and temperate zones; and this is the case.

nous (he does not say how), gave rise, at some distance from the earth, to the phenomena of the aurora.*

A large library would hardly be sufficient to hold all the memoirs and notices that have been published during the past sixty years on the subject of the aurora borealis, to say nothing of the numerous treatises on physics, meteorology, and astronomy which have devoted one or more chapters to it. Some authors have limited themselves to the simple description of what they have perceived, or to a mere exposition of their theories, while others have done more. Alexander von Humboldt has drawn in his "Cosmos" an excellent outline of the ideas which science entertained on the subject in his time; and the "Popular Astronomy" of Arago contains valuable details, well classified and arranged, on the same question.

About 1850, M. de La Rive, a Genevese physicist, endeavored to found a definite theory of the aurora borealis, and with this view artificially reproduced the phenomenon with considerable success. A prime point, which is still far removed from being fixed, is the approximate height of the meteor above the ground. Sometimes two observers, in the neighborhood of a thousand miles apart, will affirm that they have seen the same aurora at the same time and under the same aspect; at other times, the phenomenon is visible only within a radius of a few leagues. Mairan, basing his calculations on data that are not without value, concluded an elevation of two or three hundred leagues; Bravais proposed one hundred and fifty kilometres as a mean value. Other authors have supposed that the highest flashes soar to an elevation of eight hundred kilometres.

M. de La Rive has made a table of all former data, and represents that the auroræ boreales, very low in reality, hardly pass beyond the zone of clouds. They have been perceived (by Parry) projected on the flanks of mountains. Contradictions of this view are also not wanting. In support of his opinion that the meteor is low in height, M. de La Rive cites the well-established cases in which sounds have been heard during the manifestations. Sometimes a sulphurous odor has been perceived. The crackling occasioned sometimes by slow electric discharges and the odor of electrified oxygen or ozone are quite analogous. Explorers and aëronauts have pretended, according to M. de La Rive, to have gone through the aurora or through the mist that gives rise to it.

Arago had conceived the electric nature of the meteor, and assumed to predict its appearance by consulting the compass. Other facts, proving a connection between auroras and magnetic phenomena, are abundant. Jessan, in 1878, sailing on the Venus, relates that during a fine aurora all the compasses of the vessel were disordered, and they

* In this Euler made use of Newton's corpuscular theory of light, though he was an adversary of it.

went out of their way.* Under similar circumstances, Matteucci observed the iron of the Tuscan telegraphic apparatus to be so strongly magnetized that the entire service between Florence and Pisa was interrupted. In the United States, when the like conditions are prevailing, the telegraphers work their instruments without the batteries.

The beautiful arcs of light which are observed in the polar regions have their culminating point on the magnetic meridian, as the vertical plane defined by the points of a horizontal magnetic needle is called. Bravais thought these arcs, or the circles of which they form part, were concentric with the magnetic axis of the globe, or with the straight line uniting the two magnetic poles and passing through the center of the earth. The arcs, then, do not coincide with the geographical parallels, a fact which the earlier observers had already perceived. The magnetic pole is, moreover, not immovable, but its position may vary during a century several degrees in longitude or latitude.

The auroræ boreales certainly appear to be connected with a particular condition of the atmosphere, and M. de La Rive finds in this a confirmation of his theory. Nearly all the observers agree that *cirro-stratus* clouds accompany or precede the phenomena, and are frequently seen within the dark segment. Hardly less invariable is the simultaneous presence in the air of hosts of fine, transparent, microscopic needles of ice, that favor the formation of lunar halos before the aurora itself breaks out. The essential points of M. de La Rive's theory are that the earth is charged with negative fluid, and the same is the case with the strata of air very near the soil. The upper regions of the atmosphere are, on the other hand, positively electrified. This double fact, the result of certain experiments, is not denied by any one. The two electricities of opposite polarity, accumulated near the tropics in enormous masses, are combined at the poles, where the air, less moist, is a better conductor. The polar discharges produce incessant calls of fluid, if we may use such an expression, and currents of electricity are constantly departing from the equator toward the poles, one kind traveling through the rarefied gases of the upper strata, and the other kind through the ground. It is from the phenomenon of recomposition, favored by the presence of infinitesimal vesicles of air, of imperceptible snow-crystals, and of little icy needles, that proceeds the meteor of which we are trying to present the history.

M. de La Rive satisfied himself of the sufficiency of his theory by an experiment. Tubes were inserted opposite to each other into the sides of a glass bottle. The air within the bottle was exhausted by means of one of the tubes, while in the other one was fixed a rod of iron projecting on the outside, and having its other end prolonged to

* Nevertheless, if the observer is *within* the circle formed by the aurora, its action on the needle is almost nothing. This fact has been noticed more than once.

the middle of the bottle. The iron was covered with an insulating material, except at the end, and over that was a copper ring, connected with an electrical machine. The copper was then charged with positive electricity, and the iron, having been put in communication with the soil, was negatively electrified by induction. The two electricities combined in the rarefied atmosphere of the bottle, forming a luminous sheaf, like that of the lights in the Geissler tubes; but, when the iron was magnetized, a corona or concentric aureole, whence radiated brilliant jets, was formed around its free end. As a little reflection will show, the iron represented the earth and the terrestrial magnet; the copper, the upper strata of air; and the free end of the magnetized rod, the polar regions.

The fact mentioned by Mairan, that auroras are most frequently seen during the equinoctial months, March and September, is easily explained on M. de La Rive's theory. March corresponds with a period of increasing heat in the tropical part of the northern hemisphere, while September coincides with the time when fogs are condensed from vapors near the pole. In the one case, an excess of electricity is developed; in the other, a more ready combination of the two fluids. Perhaps the supposed eleven-years period, corresponding with the sun-spot period, may be explained in a similar way. There may also be secular variations in the prevalence of the phenomenon, but too little time has passed since careful observations have been made for their law to be as yet apprehended.

In the last months of 1878, M. Nordenskjöld, who was wintering in Berhing Strait, remarked on clear nights, when the moonlight was not too strong, the presence of a feebly luminous arc, with its crest toward the north-northeast. Regular in form and curvature, this arc rested on a segment of a circle which was itself limited by the horizon, and covered about 90°, or a quarter of the horizon. Its lower limit was quite clearly marked on the dark segment, probably by contrast, but its outer outline was less distinct, and it was hard to measure its thickness exactly; but that was estimated at about five degrees. The light of the arc was calm and uniform, without any appearance of rays, but dull enough, as we have said, and displayed nothing comparable to the draperies, the brilliant flashes, and the streaks of the Scandinavian auroras. M. Nordenskjöld observed it from day to day, taking notice of all the special features he could remark, and came to the following conclusions: Above the surface of the earth, at a distance of about four hundred kilometres, is situated a permanent, or nearly permanent, luminous corona, which encircles the entire globe without its direction coinciding with that of the parallels, for its center does not correspond with the north pole, but with the magnetic pole.

So our globe has, by this theory, a ring like Saturn's, but with some differences. The ring of the latter planet is around its equator.

Our ring, incomparably smaller, covers only a narrow zone of the polar regions, the center of which is at a considerable distance from the pole. The inhabitants of Saturn's equator—if there are any—look out upon a ribbon very wide in the vertical but very narrow in the horizontal direction. On the other hand, an observer in the high latitudes of Asia or America stands in the presence of a corona of little thickness, but relatively extensive; that is, the development of our ring is nearly parallel to the part of the terrestrial surface dominated by it, and which it would overshadow if it were opaque.

To this theory the objection may be offered, that no one before M. Nordenskjöld has remarked the meteor in question, while many should have done so if it is permanent. An observer standing near the auroral pole should perceive a luminous circle completely enveloping the horizon. M. Nordenskjöld replies to this by saying that the luminous arc is only a residuum of more brilliant and more complex phenomena; we can hardly hope to see it except in years when auroras are weak, or years of minima, of which the year 1878–'79 was one. Most commonly the accessory masks the principal, much in the same way that we can not see the foundations of a house while the building is standing. The light of the ring is so weak that not only the day and the twilight, but simple moonlight makes it invisible. If the sky is charged with frost, it will all disappear, and even the presence of too much vapor in the air extinguishes it. The observer must, then, be favored with dry and cold weather. If the temperature is above the freezing-point, it is useless to look for the corona. The coasts of Norway, moist with the breezes from the Gulf Stream, are badly situated to give views of it. Nearly all other regions where it could be perceived are dismal solitudes. In the second place, a spectator situated near the auroral poles would see nothing, for the horizon would hide the meteor from him in the same way that a Saturnian, who never left the high polar regions of his planet, would not be aware of the existence of his ring. Our observer, leaving the auroral pole, and going toward the magnetic south, would finally distinguish in that direction an arc gradually rising above the horizon. An entire circle of considerable width is dominated—that is the word—by the corona, which is then near the zenith; but, although the meteor may be nearer the ground at that point than anywhere else, it is not visible there, for it is too thin to be seen, looking at it vertically. Outside of this latter zone, another zone, concentric with it, enjoys the sight of the arc, now situated obliquely in the direction of the magnetic north. Further on, the arc, grazing the horizon, ceases to be visible; some time before reaching this point, in fact, it is hidden by the mists that gather in the horizon, as well as by the density of the atmosphere which the visual rays have to traverse. M. Nordenskjöld would not have been able to see it if it had been only half as luminous.

The meteor is relatively stationary, but is not rigorously motionless.

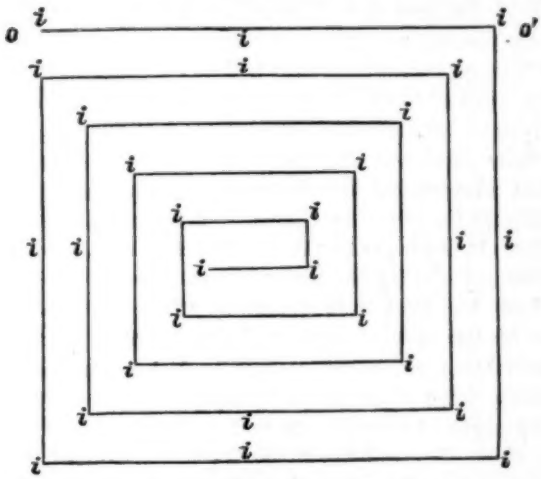
Besides the slow variations of its radius and its thickness, besides the oscillations which displace its center movements, the laws of which are worth studying, the luminous arc rises, falls, and fades away for intervals of some hours. Its light, generally uniform, is heightened by "knots of light" that play from one end to the other. Sometimes a second arc is formed parallel to the first; according to M. Nordenskjöld, this is nearly always concentric with the usual arc and situated in the same plane with it, but farther from the surface. Sometimes, also, the two arcs amalgamate, and a vertically flattened aurora results. Not rarely, supplementary arcs intervene, and frequently luminous rays play between the two arcs and into the undefined exterior space. If, now, we imagine the phenomena growing more complicated and becoming irregular, with the arcs rising above the horizon and the rays multiplying, shooting through the curves in such a way as to illuminate the vacant space, and extending themselves out toward the magnetic south in somewhat oblique directions, we have the common aurora borealis passably explained. Within the projection of the corona, toward the magnetic pole, is a zone where we may observe the auroras in a southerly direction, and, still nearer to that pole, the meteor only rarely illuminates the horizon. A few travelers, Dr. Hayes, for example, noticed this fact some time ago. The zone of no auroras embraces a circle having a radius of about eight degrees.

The labors of M. Lenström, in Lapland, are of particular interest, because they constitute a direct and definite proof of the electrical nature of the aurora borealis. They go further than those of M. de La Rive, for the Swedish observer, instead of operating in his laboratory, has succeeded in reproducing the meteor itself in the open air, and has compelled it to manifest itself, as Franklin forced the lightning to come down from the sky, so that he could examine it scientifically. We must not forget, furthermore, that it is a very meritorious thing to work in a cold of twenty degrees below zero, with a strong wind blowing and the frost all the time clogging the apparatus, having to be constantly on the watch, and enjoying no better shelter than a charcoal-burner's hut.

Not satisfied with provoking artificial auroras, the Finnish expedition, of which M. Lenström was a part, has collected a number of important data relative to the free manifestation of the phenomenon. The observations were made at Sodankylä (lat. 67° N., long. 27° E.), and Kultala (lat. 78° 30′ N., long. 27° E.), Lapland, in November and December, 1882. In the former place "the polar aurora appeared frequently of a very great intensity, but did not exhibit much variation. It generally began with a faint arc in the north, which shortly developed into an arc with rays and sometimes into draperies extending from the east to the west, most frequently a little toward the north. But little change of color took place; nearly always a pale-yellow

tint, lightly washed with green, was shown. Although the meteor was not visible continuously, there was often observed in the spectroscope, and even quite high above the horizon, the characteristic band of the auroras without the eye perceiving any trace of their light. Since this fact was remarked even when there was no snow, it could not be attributed to reflected auroral flashes. Moreover, the observers not rarely saw during the nights a light yellowish, diffuse, and phosphorescent light that illuminated the horizon and paled the stars. The effect produced was compared to that of the moon half veiled by clouds. M. Lenström and his associates attempted, on the 8th of December, 1882, to measure the height of an auroral arc above the surface of the earth. They divided themselves into two groups, and took with a theodolite the angular distance from the crest of the arc to the horizon. The two stations were four and a half kilometres apart on the same magnetic meridian, and correspondence was had during the observations by a telegraphic wire previously arranged for the purpose. They endeavored to look in concert at the same point of the meteor, but, after reiterated essays, they recognized that any particular ray visible to one party could not be seen by the other. The results of the views were irreconcilable, for the angle obtained was greater for the southern post than for the northern one, although the latter post was, *a priori*, nearer to the meteor. M. Lenström concluded from this, as M. de La Rive had done, that every observer sees his own aurora the same as every one sees his own rainbow, and that the phenomenon is produced at the height of only a few thousand metres. He also calls attention to the results obtained in Greenland by the engineer Fritze, which lead, in certain cases at least, to numbers twenty times as small. During the Swedish Polar Expedition of 1868, faint flashes or phosphorescent lights were remarked around the summits of the mountains. This fact, with which M. Lenström did not become acquainted till 1871, related as it was to some of the descriptions given by other travelers, decided him to try to provoke or facilitate the appearance of the meteor by artificial means. The first attempts date from 1871, and, like those that followed them, were made in Lapland. The enterprise being successful from the first, the experiments were resumed during the Finnish Polar Expedition of 1882, and were renewed twice on two different peaks, called respectively Oratunturi and Pietarintunturi. Oratunturi, rising more than five hundred metres above the level of the sea, is situated in latitude 67° 21′, near the village of Sodankylä. Near the topmost height of the mountain was placed a long copper wire, so bent upon itself as to form a series of squares within squares, having a total surface of nine hundred square metres, supported by insulated posts. Tin points or nibs bristled out from this connecting net at distances of half a metre apart, and the whole was connected by an insulated wire running along on stakes with a galvanometer fixed in a cabin at the foot of the peak. The galvanometer was connected with the earth by the other ex-

tremity of its own circuit.* Nearly every night after the installation of the apparatus, a yellow-white light illuminated the points without anything like it appearing on the heights in the neighborhood, while the needle of the galvanometer by its motions betrayed the passage of an electric current. The light was analyzed in the spectroscope, and gave the greenish-yellow ray that characterizes the aurora borealis. The



intensity of the glow and the deviations of the needle, moreover, varied continually. In the mean time the hoar-frost which was deposited on the wires quickly destroyed the insulation, and rendered an experiment of any duration almost impossible. The numbness of the fingers of the operators, induced by the cold, added to the difficulties of the study.

The apparatus afterward set up on Pietarintunturi, in more than 78° of latitude, was disposed in an almost identical manner, except that the surface furnished with points was a half less; but, M. Lenström remarks, the proximity to the "maximum zone" of auroras compensated for this inferiority. On the 29th of December an "auroral ray" made its appearance above the net, which it dominated vertically from a height of one hundred and twenty metres.

The difficulties of the question of the exact origin and nature of the auroral phenomena have not been solved yet; but we have good reason to believe that a long approach has been made in the recent experiments toward a solution, and grounds to believe that science will soon remove them all; and we shall no longer be able to repeat what Haüy, less than a hundred years ago, said on the same subject, "It is not always what has been known longest that is best."—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

* Professor Lenström's apparatus is represented in the figure. The wire begins at o, and connection with the galvanometer is made from the inner end. The letter *i* indicates an insulator.

DEFENSES OF THE LESSER ANIMALS.

By Professor L. GLASER.

ALL organic beings are, in the course of their lives, subject to a series of dangers and destructive influences arising from the conditions of climate and temperature, and from the competition of their fellow-beings, the universality and power of which are well illustrated in Darwin's phrase, "the struggle for existence." Yet all creatures are adjusted with most wonderful art and adaptation to the conditions of their existence and the state of the world around them. Among these adaptations are the means given to the most helpless animal existences for securing themselves against the depredations of their enemies. It is proper to observe, in considering this subject, that the protection enjoyed by the lower animal organisms is not absolute and individual, but that it is generally effective principally for the preservation of the species against destruction. For where peculiar means of protection are given to one creature, corresponding means for overcoming it are often given to another, its enemy. To the protective sharp sight of the rodents and birds are opposed the equally sharp sight of the fox and the long range of vision of the hawk. It is only in averaging the mass of such animals that we find they are secured as a whole against danger, while numerous individuals are overtaken by their enemies.

Some of the higher animals illustrate the manner in which Nature contrives to furnish special measures of precaution for its little-gifted, unalert, unarmed, and helpless creatures. The absence of teeth in the edentates is offset by shields or scale-armor; helpless beetles are furnished with hard wing-cases; the pheasants, quails, and larks of the fields are hidden from the keen vision of birds of prey by their earthy color, birds of the river and sea-shore by their resemblance in color to the sand and shingle.

Protection is required by the lower animals chiefly against the weather and against parasites and other external enemies. Frequently the place of their abode is their only and ordinarily a sufficient protection, as is the case with earth-worms and burrowing larvæ, wood-worms and fruit-borers. But such animals appear to be afflicted with particular enemies peculiarly fitted to hunt them out in their otherwise secure fortresses—in the shape of moles, mole-crickets, long-nosed hedgehogs, shrew-mice, and swine, hook-billed lapwings, and sharp-tongued woodpeckers. Frequently, also, each animal is defended by some special relation peculiar to its species. Insects, which in their comparatively brief state of maturity are secured by their powers of flight, have to be guarded, in their three previous conditions of egg, larva, and pupa, against hosts of enemies to which they would other-

wise be an easy prey and a palatable food. In the condition of the apparently lifeless and really helpless egg, they are covered by their obscurity and littleness, or by being deposited in holes and cracks, or covered with slime or hairy or silken veils and cocoons, under which they escape all but the sharpest search and rare accidents.

More curious are the many-sided and diversified means provided for the security of the young insect during the helpless larval condition. In this state, when it is destitute of eyes and wings, it is either furnished with hairy bristles or spiny envelopes, like those of numerous caterpillars, or with covers composed of fine chips, bud-scales, or other fragments, compactly woven together with a few threads of silk; or else it is screened from the sun and from parasites and birds by a plaster of mud. A group of insects, described sometimes as sack-weavers or sack-moths, make a kind of sack or pocket out of fragments of leaves and splinters, within which they perfect their growth. The case-moths make thick and close-fitting garments for their bodies, out of leaves loosely strung together, within which they hang, head downward, from the skeletons of the leaves they have attacked, undistinguishable to birds and parasites from a long bud-scale or from a dry splinter; and clothes-moths conceal themselves in similar cases made from the hair-dust or wool of the fabrics of which they have taken possession. Some beetles envelop themselves and go through their changes in balls of earth within which they inclose themselves. The larvæ of one group protect themselves by a kind of foam which they manufacture from the juice of the plants they suck. The woolly aphides are well cared for with the great tufts of wool with which they are provided, under the cover of which they suck the juices of plants and bring forth their multitudinous offspring, which given to the winds, the same hairy envelopes serve them as sails on which they are borne afar to new plantations. A species that feeds on the ash-tree takes possession of the galls that form upon it, and can not be removed without taking off the whole limb, for birds will not attack insects thus protected. These and other aphides, which are particularly injurious to fruit-trees, are so carefully protected against the ordinary attacks of external enemies that man is left to contend against them alone. The bark-lice or scale-insects are particularly difficult to reach, and seem to multiply in perfect security against all ordinary attacks.

A whole series of gall-insects provide security for their posterity by colonizing them in the swellings or knots that are produced on the trees wherever they sting the bark and lay their eggs. The larvæ, continuing to irritate the tissues of the tree, cause the knots to swell and grow correspondingly with their own growth, and thus find themselves in a well-fortified home exactly fitted to their wants. Within the galls, the naked, helpless worms are at once protected from exterior assaults of every kind and provided with an unfailing supply of food which they can reach without effort, so that their development goes

on without obstruction of any kind. According to A. Schenck, the gall-nuts of the rose are adapted to the shelter and support of the larvæ of more than two hundred species of flies, and those of the oak are also the home of numerous varieties. Malpighi, who died near the end of the seventeenth century, remarked that there was no part of the plant on which galls did not arise. The roots, runners, stalks, leaf-stems, leaves, buds, flower-stems, flowers, and fruit, all are made to serve as the nest or place of transformation for the young of one or more species of insect; but only the aphis lives upon them permanently.

Another very frequently observed means of securing young insect broods is by envelopes formed, sometimes with great apparent skill, by rollings or foldings of the leaf. Some weevils have the art of cutting out patterns of leaves, and, without wholly severing their attachment, rolling them up into a scroll, within which they deposit their eggs; and they do the whole with such mathematical accuracy that their constructions have been made the subjects of formal monographs, like those of Drs. Heis and Debey on the funnel-rollers. Specimens of these scrolls are familiar enough, as they have been observed on the hazel, beech, hornbeam, alder, birch, aspen, and vine, where the operations of the insects are in some seasons attended with injury to the crop. The caterpillars of many butterflies and moths are also sheltered in the same manner; while other caterpillars associate themselves together and spin webs for their nests, in the air between the leaves and twigs of trees. Nests of this kind are frequently found on fruit-trees and shrubbery, and afford a very good degree of protection to their inhabitants against late frosts, storms, birds, and parasites. The nest of the procession-spinner serves, curiously, only as a resting-place for the insect in the larval state, though it finally becomes the common home of the pupæ. The caterpillars, to satisfy their hunger, are accustomed to leave the nest in a kind of orderly procession, climbing up the stem of the tree to wander all over the crown of the foliage, and, after they have done their work, to return again in procession to their nest. They are avoided by man on account of the irritation produced by the sting of their hairs, and are for the same reason safe against all birds but the cuckoo. A carnivorous beetle, the *Calosoma sycophanta*, also despises their fortress and their weapons, and breaks voraciously into their communities, like a wolf into a sheep-fold. We must remember here, the consummate architectural skill with which honey-bees build up their combs of waxen cells closely joined one to another. Their whole manner of life and their professional division of labor, in which they remind us of civilized human life, provoke the query, Whence the mechanical and technical skill and the intelligence of these little creatures?

A considerable number of our insects are burrowers, and during the period of their larval development excavate, under the epidermis of the leaves and other green parts of plants, passages, small at first,

but which widen as the larvæ grow, feeding themselves from the parenchyma in which they work, and at the same time obtaining a defense against external injurious influences and disturbances. They usually leave their burrow, when about to assume the chrysalis state, by a little hole that may be found at the extreme end of the excavation, and either fall to the ground or make a cocoon, attached to some plant, in the air. Other burrowing larvæ bury themselves in the ground.

For the preservation of the chrysalis, Nature has provided many insect-larvæ with the faculty of spinning, and organs for the purpose. This function is so extraordinarily developed in the larvæ of the butterflies that a whole group of that order have been called "the spinners"; while many of these spinners—the silk-worms—have been made serviceable to human civilization. Before the spinning larva advances to its last change of skin, it selects a sheltered, dry spot—between leaves, on bark, in a hedge, in turf, or on a post—and then, drawing from the spinning-glands situated under its neck and between its head and fore-feet fine silken threads, it prepares an ample, firm, and intricate web of flock-silk for its envelope. Having completed its cocoon, it shakes off its old skin, and lays itself to sleep in this soft but solidly-made bed, while its pupa-skin hardens and it awaits the time for its next transformation; and only when disturbed from without does it show by some spasmodic motion of the posterior segment that it can still feel, and that its pupa-rest is not a death-sleep, but only a temporary repose. If the larva is provided with a hairy skin or bristles, they become interwoven with the cocoon, and a composite texture is formed, which man must be careful how he touches, or the bristles will sting his fingers and make them smart. Naked caterpillars, or larvæ, weave, like the real silk-worm, cocoons of pure silk, or, like the false-caterpillars, and the larvæ of wasps, ants, and bees, transparent, cylindric-oval envelopes of a consistency like that of parchment or waxed paper. The naked caterpillars of the Hermione moth make a kind of roof of pieces of bark over a hollow which they have excavated in the ground for their bed; and a hairy larva provides for itself in a similar manner. Many other larvæ go for the security of their pupæ into or upon the ground, where they prepare, from leaf-dust, moss, and grains of sand, a ball rough on the outside but smoothly finished within, or simply a hole in the ground, as an envelope.

Arrived at last at its perfect and free state, the insect is efficiently protected by that "mimicry" which has been much discussed by Wallace and other writers, or the likeness in color, and sometimes in other qualities, which it presents to objects that are associated with its most accustomed haunts. Some instances of this mimicry may be observed among higher animals, but it is most conspicuous and significant with insects. We need only refer to the appearance of dif-

ferent butterflies resting with their wings folded together on flowers, leaves, bark, old walls, dead wood, etc., and to the thousands of instances daily in which insects pass unobserved by being confounded in their general harmony with the objects that are nearest to them.

The shells which serve as houses to land-snails, and which the animals close in winter by their opercula, or doors, are known to all. Many snails are not provided with shells, and they secure themselves by creeping under dead leaves, stones, or pieces of wood, or into the sod and the ground.

If we regard the animals in the water we shall find that they are furnished with safeguards as well adapted to their wants as those of their fellows of the air. The larvæ hide, like those of the *Ephemeræ*, with their whole bodies in the ground, and thus escape destruction by the fish ; or they live, like the larvæ of the May-flies, in cases made of splinters of wood, pieces of rush, seeds, bits of shells, or hollow straws and stalks of weeds. Other larvæ conceal themselves in leaf-rollings on the surface of the water or beneath the floating leaves of water-plants The soft animals of the water find their protection in shells of limestone, either spirally coiled or double-valved and kept tightly closed by a strong muscle. Crustaceans are protected by the peculiar armor which gives the class its name, and which they change once a year for a suit of larger size ; some members of the family take possession of deserted shells, and concealing their hinder parts within them live thus, and carry their acquired houses about with them, as Diogenes did his tub. The coral-polyps of the ocean build from their secretions solid, branching masses of limestone, within which they conceal their jelly-like forms, furnishing another striking example of the care Nature takes for all its creatures. The boring-worms of the sea, the *Serpulæ*, and the borers of oyster and other shells, the *Sabellæ* and the *Terchellæ*, offer other examples of a similar kind. And the *Arenicolæ*, or sand-worms, like the earth-worms of the land, find their security simply by being under the cover of the sand as they crawl around for their food.—*Translated and abridged for the Popular Science Monthly from Die Natur.*

THE COMET OF 1812 AND 1883.

By Professor DANIEL KIRKWOOD.

IN the quarter of a century included between August, 1802, and August, 1827, Jean Louis Pons discovered thirty comets—twice as many as all observers besides. Of this number are the celebrated comets of short period designated as Encke's, Biela's, and Winnecke's,

as well as the comet of 1812, now visible on its first predicted return. It was originally detected on the 20th of July, and was the thirteenth discovered by Pons within ten years. Its appearance at first was that of an irregular nebula without tail or beard, and it was only visible through a telescope. By the 14th of September it was easily seen without optical aid; its tail was over two degrees in length, and the diameter of its nucleus was five or six seconds. It continued visible till October—a period of ten weeks—and was consequently well observed. Cooper's valuable work on "Cometic Orbits" contains eight sets of elements by different computers. Encke distinctly recognized the elliptic form of the orbit, and the elements which he assigned have been generally preferred. They are as follows:

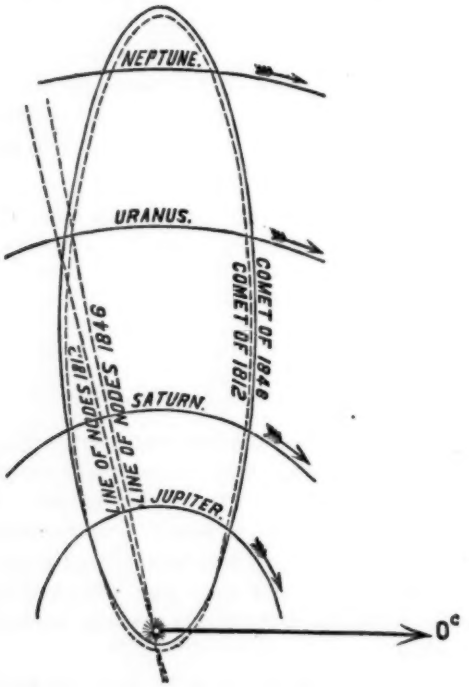
Perihelion passage	1812, Sept., 15·3136, G. M. T.
Longitude of perihelion	92° 18′ 46″
Longitude of ascending node	253° 1′ 3″
Inclination	73° 57′ 3″
Perihelion distance	0·771
Eccentricity	0·9545
Period	70·68 years.
Motion	direct.

According to Encke, therefore, the next perihelion passage was to have been expected in June, 1883—about three months before the actual discovery of the comet by Mr. W. R. Brooks. A re-discussion of the observations of 1812 had, however, been recently completed by Dr. Schulhof and M. Bossert, whose calculations gave a probable period about seven months longer than that obtained by Encke. The true period is found to be very nearly a mean between these earlier and later estimates.

On its present return the comet was first glimpsed on the night of September 1st, by Mr. William R. Brooks, Director of Red House Observatory, Phelps, New York. He was, however, prevented by clouds from verifying his conjecture of the cometary character of the nebulous speck till the evening of the 3d. Its identity with the comet of 1812 was shown on the 18th of September, by the Rev. Mr. Searles, of New York, and independently on the day following by Professor Lewis Boss, of the Dudley Observatory. The latter designated January 25, 1884, as the date of perihelion passage. Astronomers of the twentieth century will probably witness its next apparition in the summer of 1955.

The comet of 1812 is one of a remarkable group whose periods range between sixty-eight and seventy-six years, all of their aphelia being some distance beyond the orbit of Neptune. It seems, however, to be specially related to the fourth comet of 1846. The latter was discovered by De Vico, at Rome, on February 20th, and independently, by Professor G. P. Bond, February 26th. It remained visible ten weeks, and its elements were calculated by Peirce, Hind,

Van Diense, and others. The present writer has elsewhere * called attention to the close agreement of the elements of the comets of 1812 and 1846. These coincidences are seen at a glance in the following figure, where the dotted ellipse represents the orbit of the comet of 1812, and the continuous curve that of the fourth comet of 1846.



It seems difficult to regard this general similarity as accidental. A possible explanation may be found in the hypothesis of an ancient comet's separation into parts — a phenomenon known to have occurred in the case of Biela's comet. It has also been pointed out that the paths of both comets very nearly intersect the orbit of Venus; that of 1812 in true anomaly 341°, and that of 1846 in 347°.

On the hypothesis of a common origin it is obvious that these bodies must have entered the solar system at a remote epoch. It seems, therefore, quite remarkable that neither is known to have been observed before 1812. The period of De Vico's comet of 1846 is still too uncertain to be traced backward through former returns; but, with a mean period of the Pons-Brooks comet equal to the interval between the two observed apparitions, we find the dates of former perihelion passages to have been approximately as given below. The

* "Comets and Meteors," Chapter III. The nodal lines are nearly coincident, but the ascending node of the one is at the descending node of the other.

nearest corresponding dates at which comets were seen are also appended:

Former returns of the comet of 1812.	Corresponding dates at which comets were seen.	Former returns of the comet of 1812.	Corresponding dates at which comets were seen.
1741	1742	1456	1457
1670	. ..	1384	1382
1598	....	1313	1313
1527	1529	1241	1240

No comets are recorded for 1670 and 1598, and very little is known of those seen in 1742 and 1529. Some of the preceding may have been returns of the Pons-Brooks comet. The comets of 1812 and 1846, as has been shown, are both liable to great perturbation by Venus.

HOW WE SNEEZE, LAUGH, STAMMER, AND SIGH.

By FREDERIC A. FERNALD.

THE nose is an organ in more senses than one. From its resonant pipes proceed the sonorous tones which tell of blissful slumber, and the convulsive snort, varying from the mere "cat-sneeze" to the tremendous "Horatio," that has less definite meaning; while the Frenchman and the typical New-Englander (who is nearly as rare as the aborigine in New England, by-the-way) give it an important share in the production of speech. To give some physiological explanation of these and other involuntary actions of the respiratory mechanism is the object of the present article.

Snoring is produced in sleep by the passage of the breath through the pharynx when the tongue and soft palate are in certain positions. The soft palate must have fallen back in such a manner as to nearly or quite close the entrance to the nasal cavity from the throat, and the tongue must also be thrown back so far as to leave only a narrow opening between it and the soft palate. It is by the air being forced either inward or outward through this opening that the noise is produced. A snore results also when, with a closed mouth, the air is forced between the soft palate and the back wall of the pharynx into the nasal cavity. With deep breathing, perhaps accompanied by a variation in the position of the soft palate, a rattling noise may be heard in addition to the snoring, which is due to a vibration of the soft palate. Hence it is evident how flinging a pillow at a snorer, or poking him in the ribs, will often cause him to be silent even when the disciplinary measure does not awaken him, for a change of position that lets the tongue and soft palate fall a little forward secures a free passage for the air.

Grunting is a noise which is produced when, after the larynx has been perfectly closed, whether spasmodically or as a voluntary action with the object of holding the breath, the current of air thus interrupted is suddenly resumed. In the grunt we must distinguish two elements: the first is a clicking sound, and the other an explosive sound or slight report. The click is the noise produced by the meeting of air in the space left vacant when two moistened bodies are suddenly separated. It forms, however, but a very small part of the noise of grunting, and can scarcely be experimentally demonstrated. The "report" is the well-known phenomenon connected with the sudden expansion of a body of compressed air.

"*Talking through the nose*" when a person has a cold is in reality talking with the nose so stopped that less rather than more than the usual quantity of vibrating air can pass through the nasal cavity. In producing certain articulate sounds—those which occur in English are represented by *m*, *n*, and *ng*—all the vocal air escapes from the pharynx by the nose. The nasal air-passage has the general form of a resonator, and there can be no doubt but that it has a corresponding influence, and that the sounds produced by the air passing through it are strengthened by its resonance. The larger the nasal cavity the more powerful the resonance, and consequently the re-enforcement experienced by the tone. Sounds uttered with the nasal resonance, particularly the nasal vowels, are fuller and more ample than the same sounds when strengthened by the resonance of the cavity of the mouth, and it is for this reason that third-rate tragic actors like to give a nasal resonance to all the vowels in the pathetic speeches of their heroic parts. The resonance of the nasal cavity plays a part also in the formation of non-nasal articulate sounds; then, however, appearing only as a re-enforcement of the resonance of the cavity of the mouth. The directly excited nasal resonance sometimes plays an immediate part in the formation of all articulate sounds, producing the nasal "twang." But the general conception of this mode of speaking is by no means scientifically correct, every species of pronunciation in which the nasal element asserts itself with undue prominence being called "talking through the nose." It may, however, arise from two unlike causes: firstly, from a stoppage of the nasal cavity; or, secondly, from incomplete closure of the posterior entrance to this cavity. If the nasal cavity is obstructed, as when a child's nose is pinched and he is told to say "pudding," an accumulation of air forms in the back of the mouth, being unable to escape through the nose, and in the end is obliged to find exit through the mouth. The resonance is also altered, and the nasal sounds are, therefore, formed imperfectly and falsely. The same disturbance is produced by the partial obstruction of the nasal cavity which is experienced from the swollen condition of the mucous membrane, and from its increased secretion, during a "cold in the head."

A nasal twang from improper escape of air through the nasal cav-

ity may be due to a cleft palate, or to some less grave defect which prevents insufficient contact between the soft palate and the back wall of the pharynx. Various other noises emanate from the mouth and nose, accompanying certain unusual and mainly involuntary forms of respiration. These are classified by Von Meyer, from whose "Organs of Speech," in the "International Scientific Series," most of the material for this article has been obtained, as disturbances of inspiration, to which class belong hiccough, gaping, and stammering, and disturbances of expiration, under which he enumerates sneezing, coughing, laughing, and sighing.

Hiccough is the simplest of the former class, and is merely a violent inspiration caused by a convulsive contraction of the diaphragm. The ensuing expiration then takes place quietly. The air inhaled may enter principally either through the mouth or the nose, or through both equally, and in each case the accompanying noise is different. A contraction of the glottis may also take place at the same time, and in this case the entering stream of air creates, in passing between the vocal chords, a sharp, clear tone. During an attack, one inspiration in about four or five is convulsive. Hiccough arises from over-irritation of the nerves of the diaphragm, the cause of which we know to be either psychical conditions or overfilling of the stomach. When the stomach is overladen with food or with effervescing or alcoholic drinks, it resists to a greater or less extent the fall of the diaphragm; the contractions of the diaphragm necessarily become more labored, and occasionally, like other over-irritated muscles, assume a convulsive character. Frequently, however, the hiccough appears as a sign of the general over-irritation of the nervous system in hysteria, and, probably from the same reason, it may not uncommonly be observed in otherwise healthy young persons, particularly children. The above explanation of hiccough as a convulsive contraction of the diaphragm is further confirmed by the manner in which it may be stopped. It is, namely, only necessary to allow an exceedingly protracted and, at the end, forcible expiration to follow a long and quiet inspiration. The slow inspiration, especially when it is chiefly performed by the wall of the chest, prevents the phrenic nerve from being too powerfully irritated, while the long expiration gives this nerve time to recover from its over-irritation. A remedy which the writer has tested many times without a failure can always be used upon a person who has "the hiccoughs" by some one else, and generally by the sufferer himself. You say to your friend something like this: "See how close together you can hold the tips of your forefingers without their touching. No, keep your elbows out free from your sides. You can get your fingers closer than that. They are touching now. There, now hold them so. Steady." By this time you can generally ask, "Now, why don't you hiccough?" The involuntary tendency to breathe slowly and steadily when the attention is fixed on performing a deli-

cate manipulation is here what counteracts the convulsive action of the diaphragm.

Gaping is also a convulsive form of inspiration, which, however, is not so short and violent as the hiccough. In gaping, moreover, those muscles which raise the walls of the chest are at once brought into prominent action; while, further, a rapid contraction of the diaphragm is necessary before the climax can be reached, after which a somewhat rapid fall of the thorax produces a quick expiration. The important part which is played by the rise of the chest is particularly shown by the fact that in very violent gaping the head is thrown backward, and the shoulders raised, in addition to which even the arms are sometimes stretched upward. During the gaping inspiratory process the mouth is opened spasmodically, and at the same time the soft palate is spasmodically raised, closing the air-passage of the nose. The whole phenomenon, including the sense of satisfaction after the inspiration, seems an indication of a strong desire for air, and the existence of this desire under those circumstances in which gaping is generally observed—sleepiness, for instance, or weariness—is readily explainable. Such circumstances are accompanied by a general inactivity of the nervous system, from which results a weak respiratory action, insufficient for the body when awake.

Stammering results from efforts to talk while a similar action to that which produces hiccough is going on. The difference is that, in stammering, the contractile spasm of the diaphragm is longer. During its continuance no expiration can take place, and, as speech depends upon the existence of an issuing stream of air, it is impossible for a person while suffering such a spasm to produce any sound. Ineffectual and therefore exaggerated efforts to create sound with the organs of the mouth and throat give rise to distressed grimaces, and this distressed expression must necessarily be augmented by the fact that, by so long delaying expiration, a want of breath is felt and the circulation of the blood interrupted. When at length the spasm ceases, and is followed by a quick expiration, the natural condition is restored till again destroyed by a fresh spasm. But there may be no attempt to speak, and yet the cause of the phenomenon (the spasm in the diaphragm) may be experienced; in this case it will not cause stammering, and may be quite imperceptible to the observer. If, now, as appears from the above, stammering is only an occasionally observed symptom of a contractile spasm in the diaphragm, it must be clear that all attempts to cure stammering by exercising the organs of the mouth and throat must be unsuccessful, and that this defect can be efficiently treated only by following rules already given for the treatment of hiccough. A quiet, unhurried inspiration must be followed by an expiration as slow and long as possible, the issuing stream either being employed in speech or not. With this treatment the motor nerves of the diaphragm can most effectually recover from their

state of over-irritation, and return to their normal condition. We must, however, be careful not to fall into the common error of confounding *stuttering* with stammering. In stuttering the process of breathing is quite normal, and the defective speech arises only from inaptitude in the formation of sound ; this defect of speech is, therefore, peculiar to children, idiots, and persons suffering from apoplexy.

Sighing, which is classed by Von Meyer as an unusual form of expiration, is better regarded as including the preceding inspiration also. A sigh is in fact a long breath, and, like a gape, is an involuntary spurt made to catch up with the demand for air. This is true even when it arises from depressing emotion. The expiration is often the more prominent part of the action, the rapidity with which the air flows out being due to a sudden cessation of the activity of the expiratory muscles, which commonly regulate, by retarding, the issuing stream of air. In *sobbing*, air is obtained by short, abrupt inspirations, and the tears which overflow into the nasal cavity assist in causing this air to produce sound.

Sneezing is the simplest of the purely expiratory noises. Just as the hiccough depends upon a single violent spasm during inspiration, so the sneeze is due to a single violent spasm during expiration, generally of the abdominal muscles, but, when very violent, of the other expiratory muscles also. It is a reflex action which occurs after an irritation of the mucous membrane lining the air-passages of the nose, and also after irritation of the optic nerve by a bright light. A few slight contractions of the abdominal muscles are at first suppressed by some short inspirations rapidly following each other without any intervening expiration ; then follows a vigorous contraction of the abdominal muscles, by means of which the stream of air is violently driven out through the mouth and nose. In its passage through the nose, the air produces a well-known noise, which may, however, be connected with a sound produced in the vocal chords. We recognize the same peculiarity, though the action is voluntarily performed, in blowing the nose. Sneezing is not an observer of times and seasons, and often seems to choose the most inopportune moment for exhibiting its power. In such a case the impending catastrophe may be averted by pressing firmly upon some branch of the fifth nerve, say in the upper lip close under the nose.

Coughing and *laughing* are also due to a spasmodic contraction of the expiratory muscles. These acts differ from sneezing only in this respect, that, while in the latter expiration is accomplished by a single violent action, it is here characterized by a number of separate impulses of the expiratory muscles with small intervening pauses. In long-continued coughing or laughing, short inspirations, which, on account of their shortness and violence, often approach the verge of hiccoughing, are taken between the separate expirations, and, indeed, laughing after a full meal frequently leads to a fit of hiccoughs. Cough-

ing most closely resembles sneezing, not only as regards its origin, but also as regards its execution. This is a reflex action which follows an irritation of the air-passages, particularly of the windpipe and the larynx, but also of the pharynx and the nasal cavity. Stimulation of other nerves, as those of the skin by a draught of cold air, may also produce coughing. The expiratory impulses induced may attain great violence, so as in this respect to resemble the single impulse of sneezing. While, however, in sneezing, the stream of air escapes, as a rule, through the nose, in coughing it escapes through the cavity of the mouth, which is shut off by the raised soft palate from the nasal cavity, and enlarged by dropping the lower jaw, and by the depression of the floor of the cavity, the tongue at the same time being pushed forward. The closed glottis holds this air back for an instant against the pressure of the abdominal muscles, and then suddenly opens part way, letting it escape with an explosive noise, generally accompanied by a sound, shrill or deep as the case may be, produced by the vocal chords. Performed voluntarily, and with less violence, coughing assumes the form known to us as "clearing the throat." In laughing, the separate expiratory impulses are not so violent, and the stream of air passes through the fairly open mouth, or, when the mouth is shut, through the nose. It is accompanied by contractions of the muscles of the face, and is mainly involuntary, being generally caused by an impression produced upon the higher parts of the brain. Violent laughing may be caused by tickling some parts of the body. Characteristic sounds are produced in the same way as already described in coughing, and in both, when long continued, the air which from time to time is quickly inspired may produce a clear, shrill note in passing through the glottis.

THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

XXII.

I NOW come to a very important constituent of animal food, although it is not contained in beef, mutton, pork, poultry, game, fish, or any other organized animal substance. It is not even proved satisfactorily to exist in the blood, although it is somehow obtained from the blood by special glands at certain periods. I refer to *casein*, the substantial basis of cheese, which, as everybody knows, is the consolidated curd of milk.

It is evident at once that casein must exist in two forms, the soluble and insoluble, so far as the common solvent, water, is concerned. It exists in the soluble form, and completely dissolved in milk, and insoluble in cheese. When precipitated in its insoluble or coagulated

form, as the curd of new milk, it carries with it the fatty matter, or cream, and therefore, in order to study its properties in a state of purity, we must obtain it otherwise. This may be done by allowing the fat-globules of the milk to float to the surface, and then remove them—i. e., by separating the cream as by the ordinary dairy method. We thus obtain in the skimmed milk a solution of casein, but there still remains some of the fat. This may be removed by evaporating it down to solidity, and then dissolving out the fat by means of ether, which leaves the soluble casein behind. The adhering ether being evaporated, we have a fairly pure specimen of casein in its original or soluble form.

This, when dry, is an amber-colored, translucent substance, devoid of odor, and insipid. This insipidity and absence of odor of the pure and separated casein is noteworthy, as it is evidently the condition in which it exists in milk, but very different from that of the casein of cheese. My object in pointing this out is to show that in the course of the manufacture of cheese new properties are developed. Skim milk—a solution of casein—is tasteless and inodorous, while cheese, whether made from skimmed or whole milk, has a very decided flavor and odor.

If we now add some of our dry casein to water, it dissolves, forming a yellowish, viscid fluid, which, on evaporation, becomes covered with a slight film of insoluble casein, which may be readily drawn off. Some of my readers will recognize in this description the resemblance of a now well-known domestic preparation of soluble casein, condensed milk, where it is mixed with much cream, and in the ordinary preparation also much sugar. The cream dilutes the yellowness, but does not quite mask it, and the viscidity is shown by the strings which follow the spoon when a spoonful is lifted. If a concentrated solution of pure casein is exposed to the air it rapidly putrefies, and passes through a series of changes that I must not tarry to describe, beyond stating that ammonia is given off, and some crystalline substances, such as *leucine*, *tyrosine*, etc., very interesting to the physiological chemist, but not important in the kitchen, are formed.

A solution of casein in water is not coagulated by boiling; it may be repeatedly evaporated to dryness and redissolved. Upon this depends the practicability of preserving milk by evaporating it down, or "condensing." This condensed milk, however, loses a little; its albumen is sacrificed, as everybody will understand who has dipped a spoon in freshly-boiled milk and observed the skin which the spoon removes from the surface. This is coagulated albumen.

If alcohol is added to a concentrated solution of casein in water, a pseudo-coagulation occurs; the casein is precipitated as a white substance like coagulated albumen, but, if only a little alcohol is used, the solid may be redissolved in water; if, however, it is thus treated with strong alcohol, the casein becomes difficult of solution, or even quite

insoluble. Alcohol added to solid soluble casein renders it opaque, and gives it the appearance of coagulated albumen. The alcohol itself dissolves a little of this.

The characteristic coagulation of casein, or its conversion from the soluble to the insoluble form, is produced rather mysteriously by rennet. Acids precipitate it from an aqueous solution, producing an apparent coagulation, but it is not a true and complete coagulation like that effected by the rennet, for on neutralizing the acid precipitant with an alkali or metallic oxide the casein again dissolves. Excepting in the cases of acetic and lactic acids (vinegar and the acid of sour milk), which precipitate pure casein, the acid precipitates appear to be a compound of casein with the acids, and the casein is set free in its original state when the acid goes over to the alkali or basic metallic oxide. The action of rennet in the coagulation of casein is still a chemical mystery, especially when we consider the smallness of the quantity of coagulating agent required for the rapid and complete conversion.

A calf has four stomachs, the fourth being that which corresponds to ours, both in structure and functions. It is lined with a membrane, from which are secreted the gastric juice and other fluids concerned in effecting the conversion of food into chyme. A weak infusion made from a small piece of this "mucous membrane" will coagulate the casein of two or three thousand times its own quantity of milk, or the coagulation may be effected by placing a small piece of the stomach (usually salted and dried for the purpose) in the milk, and warming it for a few hours.

Many theoretical attempts have been made to explain this action of the rennet. Simon and Liebig supposed that it acts primarily as a ferment, converting the sugar of milk into lactic acid, and that this lactic acid coagulates the casein; but Selmi has shown that alkaline milk may be coagulated by rennet in the course of ten minutes, and that after the coagulation it still has an alkaline reaction. This is the case whether fresh naturally alkaline milk is used, or milk that has been artificially rendered alkaline by the addition of soda.

Casein, when thoroughly coagulated by rennet, then purified and dried, is a hard and yellowish horn-like substance. It softens and swells in water, but does not dissolve therein, nor in alcohol nor weak acids. Strong mineral acids decompose it. Alkalies dissolve it readily, and, if concentrated, decompose it on the application of heat. When moderately heated, it softens, and may be drawn into threads, and becomes elastic; at a higher temperature it fuses, swells up, carbonizes, and develops nearly the same products of distillation as the other protein compounds.

I have good and sufficient reasons for thus specifying the properties of this constituent of food. I regard it as the most important of all that I have to describe in connection with my subject—the science

of cookery. It contains (as I shall presently show) more nutritious material than any other food that is ordinarily obtainable, and its cookery is singularly neglected, is practically an unknown art, especially in this country. We commonly eat it raw, although in its raw state it is peculiarly indigestible; and in the only cooked form familiarly known among us here, that of a Welsh rabbit, or rare-bit, it is too often rendered still more indigestible, though this need not be the case.

Here, in this densely populated country, where we import so much of our food, cheese demands our most profound attention. The difficulties and cost of importing all kinds of meat, fish, and poultry, are great, while cheese may be cheaply and deliberately brought to us from any part of the world where cows or goats can be fed, and it can be stored more readily and kept longer than other kinds of animal food. All that is required to render it, next to bread, the staple food of Britons, is scientific cookery.

If I shall be able, in what is to follow, to impart to my fellow-countrymen, and more especially countrywomen, my own convictions concerning the cookability, and consequent improved digestibility, of cheese, these papers will have "done the state some service!"

XXIII.

In my last I referred generally to the high nutritive value of cheese. I will now state particulars. First, as regards the water. Taking muscular fiber without bone, i. e., selected best part of the meat, beef contains on an average 72½ per cent of water; mutton, 73½; veal, 74½; pork, 69¾; fowl, 73¾; while Cheshire cheese contains only 30⅓, and other cheeses about the same. Thus, at starting, we have in every pound of cheese rather more than twice as much solid food as in a pound of the best meat, or comparing with the average of the whole carcass, including bone, tendons, etc., the cheese has an advantage of three to one.

The following results of Mulder's analysis of casein, when compared with those by the same chemist of albumen, gelatine, and fibrin, show that there is but little difference in the ultimate chemical composition of these, so far as the constituents there named are concerned:

Carbon	53·83	Casein.
Hydrogen	7·15	
Nitrogen	15·65	
Oxygen, Sulphur	23·37	

	Albumen.	Gelatine.	Fibrin.
Carbon	53·5	50·40	52·7
Hydrogen	7·0	6·64	6·9
Nitrogen	15·5	18·34	15·4
Oxygen	22·0	24·62	23·5
Sulphur	1·6	"	1·2
Phosphorus	0·4	"	0·3

We may therefore conclude that, regarding these from the point of view of nitrogenous or flesh-forming, and carbonaceous or heat-giving constituents, these chief materials of flesh and of cheese are about equal.

The same is the case as regards the fat. The quantity in the carcass of oxen, calves, sheep, lambs, and pigs varies, according to Dr. Edward Smith, from 16 per cent to 31·3 per cent in moderately-fatted animals, while in whole-milk cheeses it varies from 21·68 per cent to 32·31 per cent, coming down in skim-milk cheeses as low as 6·3. Dr. Smith includes Neufchâtel cheese, containing 18·74 per cent among the whole-milk cheeses. He does not seem to be aware that the cheese made up between straws and sold under that name is a *ricotta*, or crude curd of skim-milk cheese. Its just value is about threepence per pound. In Italy, where it forms the basis of some delicious dishes (such as *budino di ricotta*, of which anon), it is sold for about twopence per pound or less.

There is a discrepancy in the published analyses of casein which demands explanation here, as it is of great practical importance. They generally correspond to the above of Mulder within small fractions, as shown below in those of Scherer and Dumas :

	Scherer.	Dumas.
Carbon	54·665	53·7
Hydrogen	7·465	7·2
Nitrogen	15·724	16·6
Oxygen, sulphur	22·146	22·5

In these the one hundred parts are made up without any phosphate of lime, while, according to Lehmann ("Physiological Chemistry," vol. i, p. 379, Cavendish edition), "casein that has not been treated with acids contains about six per cent of phosphate of lime ; more, consequently, than is contained in any of the protein compounds we have hitherto considered."

From this it appears that we may have casein with, and casein without, this necessary constituent of food. In precipitating casein for laboratory analysis, acids are commonly used, and thus the phosphate of lime is dissolved out ; but I am unable at present to tell my readers the precise extent to which this actually occurs in practical cheese-making where rennet is used. What I have at present learned only indicates generally that this constituent of cheese is very variable ; and I hereby suggest to those chemists who are professionally concerned in the analysis of food, that they may supply a valuable contribution to our knowledge of this subject by simply determining the phosphate of lime contained in the ash of different kinds of cheese. I would do this myself, but, having during some ten years past forsaken the laboratory for the writing-table, I have neither the tools nor the leisure for such work ; and, worse still, I have not that prime essential to practical re-

search (especially of endowed research), a staff of obedient assistants to do the drudgery.

The comparison specially demanded is between cheeses made with rennet and those Dutch and factory cheeses the curd of which has been precipitated by hydrochloric acid. Theoretical considerations point to the conclusion that in the latter much or even all of the phosphate of lime may be left in solution in the whey, and thus the food-value of the cheese seriously lowered. We must, however, suspend judgment in the mean time.

In comparing the nutritive value of cheese with that of flesh, the retention of this phosphate of lime nearly corresponds with the retention of the juices of the meat, among which are the phosphates of the flesh.

These phosphates of lime are the bone-making material of food, and have something to do in building up the brain and nervous matter, though not to the extent that is supposed by those who imagine that there is a special connection between phosphorus and the brain, or phosphorescence and spirituality. Bone contains about eleven per cent of phosphorus, brain less than one per cent.

The value of food in reference to its phosphate of lime is not merely a matter of percentage, as this salt may exist in a state of solution, as in milk, or as a solid very difficult of assimilation, as in bones. That retained in cheese is probably in an intermediate condition—not actually in solution, but so finely divided as to be readily dissolved by the acid of the gastric juice.

I may mention, in reference to this, that, when a child or other young animal takes its natural food in the form of milk, the milk is converted into unpressed cheese, or curd, prior to its digestion.

Supposing that on an average cheese contains only one half of the six per cent of phosphate of lime found, as above, in the casein, and taking into consideration the water contained in flesh, the bone, etc., we may conclude generally that one pound of average cheese contains as much nutriment as three pounds of the average material of the carcass of an ox or sheep as prepared for sale by the butcher; or, otherwise stated, a cheese of twenty pounds weight contains as much food as a sheep weighing sixty pounds as it hangs in the butcher's shop.

Now comes the practical question. Can we assimilate or convert into our own substance the cheese-food as easily as we may the flesh-food?

I reply that we certainly can not if the cheese is eaten raw; but have no doubt that we may if it be suitably cooked. Hence the paramount importance of this part of my subject. A Swiss or Scandinavian mountaineer can and does digest and assimilate raw cheese as a staple article of food, and proves its nutritive value by the result; but feebler bipeds of the plains and towns can not do the like.

I may here mention that I have recently made some experiments on the dissolving of cheese by adding sufficient alkali (carbonate of potash) to neutralize the acid it contains, thus converting the casein into its original soluble form as it existed in the milk, and have partially succeeded both with water and milk as solvents; but before reporting these results in detail I will describe some of the practically established methods of cooking cheese that are so curiously unknown or little known in this country.

In the fatherland of my grandfather, Louis Gabriel Mattieu, one of the commonest dishes of the peasant who tills his own freehold and grows his own food is a "fondevin" (I can not explain the etymology of the word, and spell it only by ear, never having seen it in print or writing). This is a mixture of cheese and eggs, the cheese grated and beaten into the egg as in making omelets, with a small addition of new milk or butter. It is placed in a little pan like a flower-pot saucer, cooked gently, served as it comes off the fire, and eaten from the vessel in which it is cooked. I have made many a hearty dinner on one of these, *plus* a lump of black bread and a small bottle of genuine but thin wine; the cost of the whole banquet at a little *auberge* being usually less than sixpence. The cheese is in a pasty condition, and partly dissolved in the milk or butter. I have tested the sustaining power of such a meal by doing some very stiff mountain-climbing and long fasting after it. It is rather too good—over-nutritious—for a man only doing sedentary work.

A diluted and delicate modification of this may be made by taking slices of bread, or bread and butter, soaking them in a batter made of eggs or milk—without flour—then placing the slices of soaked bread in a pie-dish, covering each with a thick coating of grated cheese, and thus building up a stratified deposit to fill the dish. The surplus batter may be poured over the top; or, if time is allowed for saturation, the trouble of preliminary soaking may be saved by simply pouring all the batter thus. This, when gently baked, supplies a delicious and highly nutritious dish. We call it cheese-pudding at home, but my own experience convinces me that we make a mistake in using it to supplement the joint. It is far too nutritious for this; its savory character tempts one to eat it so freely that it would be far wiser to use it as the Swiss peasant uses his *fondevin*, i. e., as the one and only dish of a good wholesome dinner.

I have tested its digestibility by eating it heartily for supper. No nightmare has followed. If I sup on a corresponding quantity of raw cheese, my sleep is miserably eventful.—*Knowledge.*

UNDER-GROUND WIRES.

By Dr. WILLIAM W. JACQUES,
ELECTRICIAN OF THE AMERICAN BELL TELEPHONE COMPANY.

THE first telegraph line constructed in this country, from Baltimore to Washington, in 1843, was intended to be laid under-ground, and the first nine miles was so laid. Four copper wires were each wound with cotton, soaked in shellac, and the whole drawn into a lead tube. This tube was laid in a trench by the side of the rail-road. Hardly was the section completed, however, when water found its way into the joints, destroying the insulation, and the conductors failed. They were accordingly replaced by wires strung on poles, and the rest of the line was constructed in this way.

In England a very similar line was built, along the line of the Great Western Railway, for a distance of thirteen miles out from the city of London. This line failed in exactly the same way as the American lines, and the pipes were dug up and placed on short posts six inches above the ground. They were, however, soon replaced by pole lines.

At various places on the Continent similar experiments were tried, and everywhere with the same results. Thus it happened that, though the first idea of telegraph engineers the world over was to run electric wires under-ground, they were everywhere obliged to string the wires on poles. In England and on the Continent there has always been a strong desire to have a part, at least, of the electric wires under-ground. In the cities, pole lines have been considered objectionable, because they disfigure the streets. Between cities, under-ground lines have been desired, because of their great safety in case of invasion, great secrecy, and reliability in case of storms.

The introduction of gutta-percha, in 1846, accordingly gave a new impetus to under-ground construction, and, though it took years of experimenting and millions of dollars, and though system after system failed in England, Germany, and the rest of Europe, there exists to-day a successful and durable system of under-ground telegraph wires connecting together the principal cities of the German Empire, besides many other under-ground lines in various parts of Europe. Many of the European cities have the telegraph lines carried from the center of the city to the outskirts, under-ground; and, in Paris, not only all of the telegraph lines, but those for electric lights, telephones, and the various other private and municipal lines, are carried in the sewers under the streets of the city.

It must be remembered, however, that these various systems have cost from ten to twenty times as much as similar overhead lines; that, for every mile of under-ground wire, there are many miles on poles;

and that in Paris, which is the only city in the world having a *complete* under-ground system, there are unusual facilities for the running of wires, as sewers large enough to walk about in extend even under the less important streets of the city. Moreover, it has been found that, for delicate and quick-working apparatus, such as automatic telegraphs, polarized relays, and, above all, the telephone, long under-ground lines are far less efficient than pole lines. There are two reasons, apart from the difficulty of securing good insulation, why these long under-ground lines are comparatively inefficient :

1. If an electric conductor be brought near to a large mass of conducting matter, as is a wire when it is taken down from a pole and buried in the earth, there appears in the current the phenomenon of *retardation*, by which each signal, instead of being sharp and distinct, is partly kept back, so that it overlaps and mingles with the next ; the result is to limit the speed of working of the apparatus ; or if, like the telephone, it be an apparatus in which the currents are necessarily extremely frequent, to confuse and destroy the signals altogether. With ordinary Morse telegraphic apparatus, this is not very troublesome on under-ground lines a hundred miles long. With delicate relays, and more especially with quick working printing telegraphs, or automatic telegraphs, such lines are very troublesome ; and, with telephones, the retardation is a very troublesome matter on under-ground lines ten miles long.

2. The second difficulty is called *induction*, and is noticed when two or more wires are run side by side and near together, as they necessarily are in an under-ground cable.

If the signals on one wire of such a cable be sharp and quick, they cause fac-simile signals on all of the neighboring wires, and this too, though the insulation may be absolutely perfect ; indeed, above a certain point, the more perfect the insulation the greater the induction. The result of this phenomenon is, that messages sent over one wire are liable to be received on all of the other wires, and, in the case of the telephone, this phenomenon is noticeable on cables one thousand feet long, and on a cable one mile long the parties on one wire can easily understand what those on the other wires are saying. For any other instrument, however, the interference only becomes annoying on much longer lines. Steady currents, like those used with electric lights, are, of course, not affected either by retardation or induction.

In our own country there is little doubt that the proper method of constructing electrical wires *between cities* is, to string them on poles in mid-air. A brief review of some of the European systems that have been constructed will convince us of this. Between the years 1847 and 1850 a system of cables, containing 2,648 miles of wire, was laid under-ground to connect Berlin with the other principal cities of Prussia. Gutta-percha-covered wires were drawn into lead tubes, which were then buried in trenches two feet deep. The cost of this

system was at least ten times that of well-constructed overhead lines. By 1850 the earliest of these lines had failed, and by 1853 the entire system was replaced by pole lines. In 1852 asimilar cable was laid in Russia, between St. Petersburg and Moscow; this worked a few years and then failed. Between 1846 and 1852 many miles of somewhat similar cables were laid in France, but, excepting those laid in the sewers of Paris, they universally failed.

In 1854 quite a number of lead-covered cables were laid in Denmark, but these were soon obliged to be abandoned in favor of overhead lines. In 1853 the Telegraph Company of England laid down a cable of ten gutta-percha-covered wires, in wooden troughs, along the high-road between London and Manchester, a distance of two hundred miles. Although neither expense nor pains were spared in the construction of this line, the cost being comparable with that of the Prussian system, two years had not elapsed before some of the wires ceased to work, and, though these were replaced and workmen kept constantly busy on the line, at the end of seven years the line was wholly abandoned in favor of overhead wires.

During the same year the Electric Telegraph Company laid down a somewhat similar system between London, Manchester, and Liverpool, though iron and earthenware pipes were substituted for the wooden troughs. Some of these lines began to fail almost as soon as completed, while others were, by constant repairing and attention, kept working for nearly ten years, when the whole was finally abandoned and overhead lines put up.

The great trouble with all of these systems, whether in England or on the Continent, was due to water, which found its way to the conductors, and of course destroyed the insulation. It was difficult to handle the wires without abrading the gutta-percha; and, when safely laid, the gutta-percha was attacked by coal-gas, vegetable growths, and the constituents of the soil. During this time many other shorter lines were constructed, but invariably with the same results.

In 1855 the French government, having failed in their attempt to use gutta-percha wires, laid down a large number of bare wires in a trench filled in with bituminous compounds. The details of this work were very carefully carried out, and the experiment is of interest because similar plans are constantly being proposed to-day. This system, costing from eight to ten times that of a thoroughly built pole line, never worked satisfactorily, and soon had to be abandoned. In 1858 the administration decided to return to gutta-percha-covered cables laid in lead tubes. The reason of this was, that some of these cables laid in the sewers of Paris, in 1846, were still in good condition. Many miles of this cable were laid, some with the lead pipe laid directly in the earth, some with it drawn again into iron pipes, and some carried through the sewers of the principal cities. Those cables laid directly in the earth soon failed, but those in iron pipes and the sewers

continued to work, and from this grew the system now used in Paris. Up to 1870 the above-described attempts, as well as many others (not recounted), had proved a series of complete failures. Since that, however, several lines have been built in England that have continued to work successfully; and in Germany successful under-ground cables have been laid down connecting together all of the principal cities of the empire. The present complete system, as used between Liverpool and Manchester, was constructed as follows: Iron or stoneware pipes were laid from one to two feet below the level of the road-side with flush-boxes coming to the surface every two hundred yards. Into these was drawn a cable of gutta-percha-covered wires. The joints were carefully made in the pipes, and they were smoothed inside to prevent any possible abrading of the cable. The route was especially selected through a low and marshy section of country, so that the pipes were almost constantly filled with water—this being the best possible condition for the preservation of the gutta-percha. The present European system dates from 1875. The cable is similar to that used for submarine purposes. It consists of seven copper wires, each coated with two layers of gutta-percha and two of Chatterton's compound, and the whole covered with an armor of galvanized-iron wires. This cable is laid in a trench by the road-side, and comes to the surface only inside the telegraph-offices in the cities. Its cost was nearly twenty times the cost of a well-built pole line.

Although both the English and the German systems are successfully working lines of telegraph, they are far less efficient than pole lines of the same length. The speed of working even the ordinary instruments is limited; serious trouble appears in attempting to use fast-working machines, or automatic senders, and the use of the telephone is impossible.

I think these facts have sufficiently demonstrated that for long lines of telegraph, stretching from city to city, here in America, pole lines, which can be cheaply built, easily repaired, and where the wires can be removed from the retarding influence of the earth and the inductive influences on each other, are decidedly superior to underground lines.

Within our large cities the problem presented is somewhat different. During the last few years the number of electric wires has rapidly increased, especially since the introduction of the telephone and electric light, and the probability is that the next few years will show a further large increase. If these wires are run on poles, they not only disfigure the streets, but seriously interfere with the operations of firemen in case of fire, as we have repeatedly seen during the last few years. A cobweb of wires running over the house-tops requires the linemen to continually tramp through the houses and over the roofs, causing annoyance to the tenants and damage to the buildings. Moreover, wires fixed to house-tops are subject to removal at

the whim of the owner, and they have to be continually removed from building to building as the good-will of each owner is exhausted.

In almost all of the large cities the question is now being asked, Why can not all of these wires be buried along with the gas and water pipes under the streets? In answer, I propose to describe briefly what has been done in this direction in European cities, then to look at some experiments lately made in this country, and thus to show how far such a plan is and how far it is not practicable.

In Paris, *all* the wires are carried in the sewers under-ground.

In London, the *telegraph* wires are carried from the central office to many of the branch offices and to the railways leading out of the city under-ground.

In Vienna, Prague, Brünn, Munich, Augsburg, Nuremberg, and many other cities, the telegraph-wires are carried under-ground by armored cables to the outside of the city.

In the German cities we have seen that many of the telegraph-wires are carried under-ground from the center of the city to connect with cables running to other cities.

Telephone wires, electric-light wires, and a large majority of telegraph wires in European cities are, however, as in America, carried over house-tops or on poles.

The cable most generally made in Paris consists of seven gutta-percha-covered wires laid into a cable covered with tarred hemp and drawn into a lead pipe; this pipe is fastened by hooks to the side-wall of the sewer. The cables are thus easy of access, and any new cables may be added as required without disturbing those already in use. In some of the newer cables wires covered with cotton soaked in paraffine are used instead of gutta-percha-covered wires. The distances within this city are so short that neither induction nor retardation has to be considered in the telegraph wires. Electric-lighting wires, we have seen, are not affected. The telephone wires are in Paris protected from these evils by an extremely simple though expensive device. Instead of a single wire for each circuit, two wires twisted together are used, the current going out over one and returning over the other. Such a device is called a "metallic circuit." Any outside disturbing circuit tends to induce, in the two wires of the metallic circuit, equal and opposite currents, which neutralize and disappear. In such an arrangement, too, there is a minimum of retardation.

There are several thousand miles of wire in the sewers of Paris, and the cost of the gutta-percha-covered cables is about $140 per mile of wire, or about five times the cost of a pole line to do the same work. As telephone cables require two wires for each circuit, this estimate would have to be doubled. The paraffined cables are, however, considerably cheaper, though their durability has not yet been proved. The cost for repairs is very small, and some cables have not been touched for twenty years. In any other city than Paris, the

above figures would be very greatly increased by the cost of underground piping and chambers to contain the cables.

It is thus demonstrated that it is *technically* possible to place all of the wires in a city under-ground. It is also demonstrated that the cost, even when a large number of wires run side by side, is enormously increased. For many purposes, as telephony or electric lighting, a considerable number of wires start out from a central office together, but continually bifurcate until single wires run to the houses of the subscribers. The cost of one wire by itself is vastly larger than where many are run together, the cost of the pipe and for laying being not much greater for fifty wires than for one, and the cost of single wire cables being greater per mile of wire than multiple wire cables, so that the expense of putting such a system as one of our telephone exchanges entirely under-ground would place the cost of the instruments entirely out of reach of the subscribers. If telephones were required in every house, as are gas and water, such a system might be practicable, but at present that is not likely to be the case.

The American Bell Telephone Company has recently constructed two short lines of under-ground wires in the business section of Boston, and these give us excellent data from which to judge of the extent of technical practicability and the expense of putting all wires underground. We have seen that in Paris the retardation and induction are both obviated by the use of double and twisted wires in metallic circuit. It is necessary that *all* of the wires be in metallic circuit, for, if a metallic circuit be connected to a single-line circuit, the disturbances are not removed. If a subscriber in one city wishes to talk with a subscriber in a neighboring city, both cities must have metallic-circuit systems and metallic circuits between the two cities. As the two lines constructed in Boston are short, only about one quarter of a mile each, it was deemed best to use single-line circuits, hoping that the induction and retardation on so short lines would not be serious.

The system is constructed as follows: Eight wrought-iron pipes, three inches in diameter, are laid side by side in two rows, about four feet below the surface. At each street corner is built a brick chamber, large enough to admit a man, and with a cover flush with the street. The cables, of which several kinds are in use, run out from the basement of the central office through these pipes and up the side of buildings to roofs, from which they spread out to the subscribers by means of ordinary overhead lines.

Conversation over these lines is not so easily carried on as by means of overhead wires, and it is frequently possible to overhear other conversation. This prohibits further extension of the single-wire system under-ground, for technical reasons. The cost of the piping and chambers is in round numbers $50,000 per mile, and these pipes are intended to accommodate one thousand wires. The cost of the cables is from

$60 to $150 per mile for each circuit, according to the kind of cable used.

In round numbers we may estimate the total cost for one thousand wires at $150,000 per mile, or $150 per mile per circuit. The cost of piping and chambers would be nearly as great for one hundred circuits as for one thousand, as the cost of chambers and the labor of excavating and filling would be the same; so that the cost for one hundred wires may be estimated at $50,000 per mile, or $500 per mile per conductor. The cost per conductor thus increases enormously as the number of conductors diminishes, so that it would be clearly impossible to follow out the wires of an exchange system in all of their bifurcations.

It may be argued that cheaper methods of laying wires may be devised; but the experience of forty years has led continually to more and more expensive systems. If, then, the present method of running wires overhead is objectionable, and the expense of running them under-ground is so great as to put the cost of telephones, electric lights, and other electrical appliances out of the reach of would-be users, how are the wires to be run?

It seems to the writer that much of the inconvenience may be obviated, and without greatly increasing the expense, by adopting the following plan: From each telephone exchange, electric-lighting station, or other center of electric wires, run overhead cables out to a considerable number of points about the city, some one of which would be quite near to each subscriber. From each of these points to the various subscribers run short stretches of ordinary house-top wire. In this way hundreds of single wires would be gathered into small and inoffensive cables, and the enormous wooden structures would be replaced by small cable supports of brick or iron. In no place would there be the offensive multiplicity of wires. Such a system would be more durable, needing fewer repairs, than the present, and would not be much more expensive. For any other apparatus than telephones, retardation and induction would not be felt on so short cables. With telephone cables of moderate length these troubles would not be serious, and, if longer cables were necessary, metallic circuits could be used.

AN OVERDOSE OF HASHEESH.

By MARY C. HUNGERFORD.

BEING one of the grand army of sufferers from headache, I took, last summer, by order of my physician, three small daily doses of Indian hemp (hasheesh), in the hope of holding my intimate enemy in check. Not discovering any of the stimulative effects of the drug, even after continual increase of the dose, I grew to regard it as a

very harmless and inactive medicine, and one day, when I was assured by some familiar symptoms that my perpetual dull headache was about to assume an aggravated and acute form, such as usually sent me to bed for a number of days, I took, in the desperate hope of forestalling the attack, a much larger quantity of hasheesh than had ever been prescribed. Twenty minutes later I was seized with a strange sinking or faintness, which gave my family so much alarm that they telephoned at once for the doctor, who came in thirty minutes after the summons, bringing, as he had been requested, another practitioner with him.

I had just rallied from the third faint, as I call the sinking turns, for want of a more descriptive name, and was rapidly relapsing into another, when the doctors came. One of them asked at once if I had been taking anything unusual, and a friend who had been sent for remembered that I had been experimenting with hasheesh. The physicians asked then the size and time of the last dose, but I could not answer. I heard them distinctly, but my lips were sealed. Undoubtedly my looks conveyed a desire to speak, for Dr. G——, bending over me, asked if I had taken a much larger quantity than he ordered. I was half sitting up on the bed when he asked me that question, and, with all my energies bent upon giving him to understand that I had taken an overdose, I bowed my head, and at once became unconscious of everything except that bowing, which I kept up with ever-increasing force for seven or eight hours, according to my computation of time. I felt the veins of my throat swell nearly to bursting, and the cords tighten painfully, as, impelled by an irresistible force, I nodded like a wooden mandarin in a tea-store.

In the midst of it all I left my body, and quietly from the foot of the bed watched my unhappy self nodding with frightful velocity. I glanced indignantly at the shamefully indifferent group that did not even appear to notice the frantic motions, and resumed my place in my living temple of flesh in time to recover sufficiently to observe one doctor lift his finger from my wrist, where he had laid it to count the pulsations just as I lapsed into unconsciousness, and say to the other: "I think she moved her head. She means us to understand that she has taken largely of the cannabis Indica." So, in the long, interminable hours I had been nodding my head off, only time enough had elapsed to count my pulse, and the violent motions of my head had in fact been barely noticeable. This exaggerated appreciation of sight, motion, and sound is, I am told, a well-known effect of hasheesh, but I was ignorant of that fact then, and, even if I had not been, probably the mental torture I underwent during the time it enchained my faculties would not have been lessened, as I seemed to have no power to reason with myself, even in the semi-conscious intervals which came between the spells.

These intervals grew shorter, and in them I had no power to speak.

My lips and face seemed to myself to be rigid and stony. I thought that I was dying, and, instead of the peace which I had always hoped would wait on my last moments, I was filled with a bitter, dark despair. It was not only death that I feared with a wild, unreasoning terror, but there was a fearful expectation of judgment, which must, I think, be like the torture of lost souls. I felt half sundered from the flesh, and my spiritual sufferings seemed to have begun, although I was conscious of living still.

One terrible reality—I can hardly term it a fancy even now—that came to me again and again, was so painful that it must, I fear, always be a vividly remembered agony. Like dreams, its vagaries can be accounted for by association of ideas past and passing, but the suffering was so intense and the memory of it so haunting that I have acquired a horror of death unknown to me before. I died, as I believed, although by a strange double consciousness I knew that I should again reanimate the body I had left. In leaving it I did not soar away, as one delights to think of the freed spirits soaring. Neither did I linger around dear, familiar scenes. I sank, an intangible, impalpable shape, through the bed, the floors, the cellar, the earth, down, down, down! As if I had been a fragment of glass dropping through the ocean, I dropped uninterruptedly through the earth and its atmosphere, and then fell on and on forever. I was perfectly composed, and speculated curiously upon the strange circumstance that even in going through the solid earth there was no displacement of material, and in my descent I gathered no momentum. I discovered that I was transparent and deprived of all power of volition, as well as bereft of the faculties belonging to humanity. But in place of my lost senses I had a marvelously keen sixth sense or power, which I can only describe as an intense superhuman consciousness that in some way embraced all the five and went immeasurably beyond them. As time went on, and my dropping through space continued, I became filled with the most profound loneliness, and a desperate fear took hold of me that I should be thus alone for evermore, and fall and fall eternally without finding rest.

"Where," I thought, "is the Saviour, who has called his own to his side? Has he forsaken me now?" And I strove in my dumb agony to cry to him. There was, it seemed to me, a forgotten text which, if remembered, would be the spell to stop my fatal falling and secure my salvation. I sought in my memory for it, I prayed to recall it, I fought for it madly, wrestling against the terrible fate which seemed to withhold it. Single words of it came to me in disconnected mockery, but erased themselves instantaneously. Mentally, I writhed in such hopeless agony that, in thinking of it, I wonder I could have borne such excess of emotion and lived. It was not the small fact of life or death that was at stake, but a soul's everlasting weal.

Suddenly it came. The thick darkness through which I was sink-

ing became illuminated with a strange lurid light, and the air, space, atmosphere, whatever it might be called, separated and formed a wide black-sided opening, like the deadly pit which shows itself in the center of a maelstrom. Then, as I sank slowly into this chasm, from an immeasurable distance above me, yet forcibly distinct, the words I longed for were uttered in a voice of heavenly sweetness: "He that believeth on *me* hath everlasting life, and shall not come unto condemnation." My intense over-natural consciousness took possession of these words, which were, I knew, my seal of safety, my passport to heaven. For one wild instant a flash of ineffable joy, the joy of a ransomed soul, was mine. I triumphed over sin and hell and the unutterable horrors of the second death. Then I plunged again into the outer darkness of the damned. For the talisman which had been so suddenly revealed was, as if in mockery, as suddenly snatched from me, and, as before, obliterated from my recollection.

Then all the chaos beyond the gap into which I was falling became convulsed, as if shaken by wind and storm. Hideous sounds of souls in torment, and still more hideous peals of mocking, fiendish laughter, took the place of the hitherto oppressive silence. I was consumed by a fearful, stinging remorse for the sins done in the body. Unlike the experience of the drowning, my sins did not present themselves to my remembrance in an array of mathematical accuracy. On the contrary, not one was specifically recalled, but, if my daily walk and conversation had through life been entirely reprobate, and the worst of crimes my constant pastimes, my consequent agony of self-reproach could not have been greater. My conscience, in its condition of exaggerated self-accusation, was not only the worm that never dieth, but a viper that would sting eternally, a ravening beast that, still insatiate, would rend and gnaw everlastingly.

I began then, without having reached any goal, and for no apparent reason, to ascend with neither more nor less swiftness than I had gone down, and in the same recumbent position in which my forsaken body lay upon the bed a fathomless distance above, and which I had been all the time powerless to change. Even the dress, a thin, figured Swiss muslin, was the same, although a hundred times more diaphanous. Even in my agonies of remorse I noticed how undisturbed by my falling were its filmy folds. There was not even a flutter in the delicate lace with which it was ornamented. As I rose, a great and terrible voice, from a vast distance, pronounced my doom in these words of startling import: "In life you declared the negation of the supernatural. For truth you took a false philosophy. You denied the power of Christ in time—you shall feel it in eternity. In life, you turned from him—in death, he turns from you. Fall, fall, fall, to rise again in hopeless misery, and sink again in lonely agony forever!" All space took up the last four words of my terrible sentence, and myriads of voices, some sweet and sad, some with wicked, vindictive glee, echoed

and re-echoed like a refrain, "In lonely agony forever!" Then ensued a wild and terrible commingling of unsyllabled sounds, so unearthly that it is not in the power of language to fitly describe them. It was something like a mighty Niagara of shrieks and groans, combined with the fearful din and crash of thousands of battles and the thunderous roar of a stormy sea. Over it all came again the same grandly dominant voice, sternly reiterating the four last words of doom, "In lonely agony forever!" and all the universe seemed to vibrate with them.

Silence reigned again. A strange, brassy light prevailed; rapid and fierce lightning flashed incessantly in all directions, and the shaft-like opening about me closed together. Impelled by a resistless force I still rose, although now against a crushing pressure and an active resistance which seemed to beat me back, and I fought my upward way in an agony which resembled nothing so much as the terrible moment when, from strangling or suffocation, all the forces of life struggle against death, and wrestle madly for another breath. In place of the woful sounds now reigned a deadly stillness, broken only at long but regular intervals by a loud report, as if a cannon, louder than any I ever heard on earth, were discharged at my side, almost shot into me, I might say, for the sound appeared to rend me from head to foot, and then die away into the dark chaos about me in strange, shuddering reverberations. Even in the misery of my ascending I was filled with a dread expectancy of the cruel sound. It gave me a feeling of acute physical torture, with a lingering intensity that bodily suffering could not have. It was repeated an incredible number of times, and always with the same suffering and shock to me. At last the sound came oftener, but with less force, and I seemed again nearing the shores of time. Dimly in the far distance I saw the room I had left, myself lying still and death-like upon the bed, and the friends watching me. I knew, with no pleasure in the knowledge, that I should presently reanimate the form I had left. Then, silently and invisibly, I floated into the room, and was one with myself again.

Faint and exhausted, but conscious, the seal of silence still on my lips, with all the energy I was capable of I struggled to speak, to move, to make some sign which my friends would understand; but I was as mutely powerless as if in the clutch of paralysis. I could hear every word that was spoken, but the sound seemed strangely far away. I could not open my eyes without a stupendous effort, and then only for an instant. "She is conscious now," I heard one of the doctors say, and he gently lifted the lids of my eyes and looked into them. I tried my best then to throw all the intelligence I could into them, and returned his look with one of recognition. But, even with my eyes fixed on his, I felt myself going again in spite of my craving to stay. I longed to implore the doctor to save me, to keep me from the unutterable anguish of falling into the vastness and vagueness of that shadowy

sea of nothingness again. I clasped my hands in wild entreaty; I was shaken by horrible convulsions—so, at least, it seemed to me at the time—but, beyond a slight quivering of the fingers, no movement was discernible by the others. I was unable to account for the apathy with which my dearest friends regarded my violent movements, and could only suppose it was because my condition was so hopeless that they knew any effort to help me would be futile.

For five hours I remained in the same condition—short intervals of half-consciousness, and then long lapses into the agonizing experience I have described. Six times the door of time seemed to close on me, and I was thrust shuddering into a hopeless eternity, each time falling, as at first, into that terrible abyss wrapped in the fearful dread of the unknown. Always there were the same utter helplessness and the same harrowing desire to rest upon something, to stop, if but for an instant, to feel some support beneath; and through all the horrors of my sinking the same solemn and remorseful certainty penetrated my consciousness that, had I not in life questioned the power of Christ to save, I should have felt under me the "everlasting arms" bearing me safely to an immortality of bliss. There was no variation in my trances; always the same horror came, and each time when sensibility partially returned I fought against my fate and struggled to avert it. But I never could compel my lips to speak, and the violent paroxysms my agonizing dread threw me into were all unseen by my friends, for in reality, as I was afterward told, I made no motion except a slight muscular twitching of the fingers.

Later on, when the effect of the drug was lessening, although the spells or trances recurred, the intervals were long, and in them I seemed to regain clearer reasoning power and was able to account for some of my hallucinations. Even when my returns to consciousness were very partial, Dr. G—— had made me inhale small quantities of nitrite of amyl to maintain the action of the heart, which it was the tendency of the excess of hasheesh to diminish. Coming out of the last trance, I discovered that the measured rending report like the discharge of a cannon which attended my upward way was the throbbing of my own heart. As I sank I was probably too unconscious to notice it, but always, as it made itself heard, my falling ceased and the pain of my ascending began. The immense time between the throbs gives me as I remember it an idea of infinite duration that was impossible to me before.

For several days I had slight relapses into the trance-like state I have tried to describe, each being preceded by a feeling of profound dejection. I felt myself going as before, but by a desperate effort of will saved myself from falling far into the shadowy horrors which I saw before me. I dragged myself back from my fate, faint and exhausted and with a melancholy belief that I was cut off from human sympathy, and my wretched destiny must always be unsuspected by

my friends, for I could not bring myself to speak to any one of the dreadful foretaste of the hereafter I firmly believed I had experienced. On one of these occasions, when I felt myself falling from life, I saw a great black ocean like a rocky wall bounding the formless chaos into which I sank. As I watched in descending the long line of towering, tumultuous waves break against some invisible barrier, a sighing whisper by my side told me each tiny drop of spray was a human existence which in that passing instant had its birth, life, and death.

"How short a life!" was my unspoken thought.

"Not short in time," was the answer. "A lifetime there is shorter than the breaking of a bubble here. Each wave is a world, a piece of here, that serves its purpose in the universal system, then returns again to be reabsorbed into infinity."

"How pitifully sad is life!" were the words I formed in my mind as I felt myself going back to the frame I had quitted.

"How pitifully sadder to have had no life, for only through life can the gate of this bliss be entered!" was the whispered answer. "I never lived—I never shall."

"What are you, then?"

I had taken my place again among the living when the answer came, a sighing whisper still, but so vividly distinct that I looked about me suddenly to see if others besides myself could hear the strange words:

"Woe, woe! I am an unreal actual, a formless atom, and of such as I am is chaos made."

THE CAUSES OF EARTHQUAKES.

By M. DAUBRÉE,
OF THE INSTITUTE OF FRANCE.

THE causes of earthquakes have long been the subject of many conjectures. The numerous investigations of later years have contributed much to define their characters; and several data recently acquired tend further to make their mechanism clear. It is known that the shocks are by no means distributed at hap-hazard over the surface of the globe. The countries where the strata have preserved their original horizontal position, like the north of France, a part of Belgium, and the most of Russia, are privileged with tranquillity. Violent commotions are manifested particularly in regions that have suffered considerable mechanical accidents, and have acquired their last relief at a recent epoch, like the region of the Alps, Italy, and Sicily.

The tracts that are simultaneously disturbed by the same shock most frequently comprise arcs of from 5° to 15°, or from 300 to 1,500 kilometres. They rarely include a much more considerable fraction

of the globe; although the celebrated catastrophe at Lisbon on the 1st of November, 1755, extended over some 17° or 18°, into Africa and the two Americas, or over a surface equal to about four times that of Europe.

The detailed examination of many earthquakes has enabled us to determine the center of the shocks as well as the contours of the disturbed areas. From the manner in which the latter surfaces agree with the lines of pre-existing dislocations, several of the most distinguished geologists, including Mr. Dana, M. Suess, and Albert Heim, have considered the shocks in question as connected with the formation of chains of mountains, of which they may be a kind of continuation.

In fact, the crust of the earth everywhere shows the enormous effects exercised by the lateral pressures that have been in operation at all epochs. The strata, bent and bent over again many times through thousands of metres of thickness, as well as the great fractures that traverse them, are the eloquent witnesses of these mechanical actions. Notwithstanding the apparent tranquillity now reigning on the surface of the globe, equilibrium does not exist in the earth, and commotions have not been arrested in its depths. The proof of this is found, not only in earthquakes, but also in the slow movements of the soil, of elevation and depression—a kind of warping, which has continued to manifest itself within historical times in all parts of the globe. It is conceivable that slow actions of this kind, after more or less prolonged strains, may end in abrupt movements, as Élie de Beaumont supposed. We can see, also, in experiments intended to imitate the bending of strata, how gradual inflections lead all at once to fractures and outbursts. Simple cavings-in, in deep cavities, have also been regarded as possibly giving rise to earthquakes; and this opinion has been adopted by M. Boussingault after the well-known observations he made in the Andes. There is, in fact, nothing to prove that disturbances of these different kinds do not take place in the interior of the globe; but we may certainly consider them as the general cause of earthquakes. These shocks are, however, most commonly in evident connection with volcanoes; and it is in the neighborhood of the latter that they are especially frequent. As is well known, every volcanic eruption is announced by precursory earthquakes, the violence of which is stilled when an outlet is opened for the vapor of water which is successively the cause of the subterranean agitations and the projecting agent of all the eruptions. The tension of the vapor in the volcanic reservoirs must be very high. Thus, that pressure which forces the lava up to more than 3,000 metres above the sea, to the top of Etna, can not be less than a thousand atmospheres.

An attentive study of the phenomena confirms the attribution of the cause of the shocks, however violent they may be, to the vapor of water. It is sufficient for this to be the case for vaporization to take

place at a temperature of 1,000° C. (1,800° Fahr.), approximately that of lava, and under a volume equivalent to that of the water in the liquid state whence the vapor is derived. Under these conditions, we must suppose the vaporization to be total, for the critical temperature, above which the liquefaction of vapor can not be realized, is, according to M. Clausius, 332° C. (629° F.). The pressure, of which it is also possible to make an approximate estimate, then becomes comparable to that of the most powerfully explosive gases, and is, consequently, capable of producing very considerable dynamic effects. These effects may also be produced at a much lower temperature than that of lavas at 500° C. (900° F.); for example, if we suppose that the volume imposed upon the vapor is so limited as to correspond to a density of 0·8 or 0·9. No doubt such conditions are realized in the lower regions of the globe, where water is confined within limited spaces, and as hot as the melted rocks which we see gushing out from the surface at a temperature of 1,000° C. (1,800° F.) or more. We shall see, however, that such depths and such a temperature are not necessary.

The vapor of water when superheated acquires a power of which the most terrible boiler-explosions could give no idea if we had not the result before our eyes. The tubes of the best quality of iron that I used in observing the action of superheated water in the formation of silicates had an inside diameter of twenty-one millimetres and were eleven millimetres thick. They sometimes exploded, and were projected into the air with a noise like that of the firing of a cannon. Before bursting, the tubes swelled out into bulbous forms, and rents were opened in the middle of the bulbs. If the iron had no flaws and according to the estimate that it would preserve up to 450° C. (810° F.), the temperature to which it was raised, the same tenacity it had when cold, such rents must have indicated a pressure of several thousand atmospheres. A few cubic centimetres of water were sufficient to produce an effect like that; and, considering the small dimensions of the inside of the tubes as compared with the volume of the water, the vapor must have reached a density of about 0·9. If we apply the data we possess to the depths of the globe, it is not difficult to conceive very simple dispositions in which the vapor of water, under the conditions we have just determined, will suddenly provoke shocks or series of shocks that will too often make themselves felt on the surface. Whatever conception we may form of the volcanic reservoirs, we must admit it to be very probable that solutions of continuity exist between the soft or fluid masses in fusion and the solid masses superposed over them. Moreover, cavities may also exist in the solid rocks themselves that lie over the soft masses. On the other hand, the incessant losses, which these internal reservoirs suffer in consequence of the enormous volumes of water in the condition of vapor which they disengage every day, are probably repaired by supplies from the surface.

I have shown by experiment that these supplies may be transmitted through the pores of some kinds of rocks. Simple capillary action, in conjunction with gravity, may force water to penetrate against very strong counter-pressure, from the superficial and cooler regions of the globe, to deep and hot regions, where, by reason of the temperature and pressure it acquires there, it becomes capable of producing very great mechanical and chemical effects. If we suppose that water penetrates, either directly or after a halt in a reservoir where it has remained liquid, to masses in fusion, so as to acquire there an enormous tension and an explosive force, we shall have the cause of the anterior real explosions and of the instantaneous shocks due to gases at high pressure. If the cavities, instead of forming a single reservoir, are divided into several parts or distinct compartments, there is no reason why the tension of the vapor should be the same in the different receivers, provided they are separated by walls of rock. The pressure may even be very different in two or more of them. This admitted, if a separating wall is broken by excess of pressure or melted by the heat, vapor at high pressure will be set in motion, and in the presence of the solid masses upon which it will strike it will behave just as if there had been an instantaneous formation of vapor, as we supposed in the former case.

It is very hard to establish, as has been attempted, a clear line of demarkation between the character of the earthquakes of volcanic regions proper and of regions without volcanoes, such as Portugal, Asia Minor (Chios, April 3, 1881, five thousand victims), Syria, Algeria, and the rim of the Mediterranean generally. In both classes, the characteristic manifestations which we perceive are the same. If, as some assume, the internal movements of the rocks were a cause of real earthquakes, it could only be because those internal movements mechanically developed heat, and in that way provoked the formation of vapor. But, in the recently disturbed regions we have especially in view, which are the seat of so frequent shocks, another cause is much more probable. There doubtless remain in them interstices and interior cavities that permit the access of water to the hot regions. The depth of the centers of disturbance of earthquakes has been estimated, in different cases, by calculations only grossly approximate, at eleven kilometres, twenty-seven kilometres, and thirty-eight kilometres. In any case, such depth, though very slight in comparison with the length of the radius of the earth, is great enough for the temperature at the normal rate of increase to be very high ; and the same will also be the case with the water that may be present there. Now, as we have already seen, a temperature of 500° C. (900° Fahr.) is sufficient to cause water to explode with violence.

It is certainly in the largest number of cases very difficult to admit collisions of solid bodies in the interior as the moving causes of earthquakes. How, for instance, can we conceive that so violent and ex-

tensive an earthquake as that of Lisbon on the 1st of November, 1755, was produced in this way? John Mitchell (Royal Society, 1760, vol. x, p. 751) drew from this memorable example the conclusion that the vapor of water intervenes in these shocks as well as in the eruptions of volcanoes. Manifest effects of a class of internal explosions, undoubtedly due to the production or sudden moving of a great quantity of superheated vapor, are exhibited at the present epoch, and are not rare. Such explosions, for instance, are exceptionally formidable in the region of Java, and the mind is naturally led to the one which has just convulsed the zone between that island and Sumatra, which has caused the disappearance of the island of Krakatoa and its mountains, has raised other mountains, and has claimed more than forty thousand victims.

At a period more remote from us, the explosive force of interior gases gave rise to very remarkable circular cavities, which have been called "craters of explosion," and are well known. Examples of them are found in Auvergne (Lake Pavin) and in the district of the Eifel, where the stratified beds have been sharply cut as if with a punch. What gases thus put in motion are capable of, as a mechanical power, could hardly have been suspected till since the explosive effects of gun-cotton, nitroglycerine, and dynamite, have been known. The effects of compressed air in the air-gun and of the powder-gases in fire-arms have been wonderfully surpassed, for we now measure explosive pressures of six thousand atmospheres and more. In the experiments in which I have had occasion to observe gases at high pressure in order to explain the action that a meteor coming with planetary speed is subjected to on the part of the atmosphere into which it plunges, I have been surprised at witnessing the great energy of gaseous masses. They engrave themselves deeply, as if with a burner, into the pieces of steel that are opposed to them, and of themselves reduce a part of it to an impalpable dust shot into the atmosphere as if it were volcanic ashes. It is no less surprising—and this observation is of much importance in explaining the problem that occupies us—to remark the tenuity of the gaseous mass that produces such results. Yet its force causes ruptures which the pressure of a weight six hundred thousand times heavier than the gas could not effect!

In short, gaseous movements under high pressure, put in operation from time to time by a simple mechanism like what Nature can and does present, will account for all the essential features of earthquakes. Much better than the hypothesis of interior collisions of solid bodies, they explain the effect of the shock, resembling the blows of a ram, their violence, their frequent succession, and their recurrence in the same regions after many centuries; they explain also the production of earthquakes in regions of dislocation, especially in those in which the disturbance is recent, and their subordination to deep fractures of the crust of the earth.

Earthquakes seem to be volcanic eruptions that are suppressed because they can not find any outlet, nearly as Dolomieu thought. The motive power of gases, the immense effects of which we can see in the protuberances or jets shot out from the sun with prodigious speed and of enormous dimensions, appears to be sufficiently considerable in the depths of the globe also to explain all the effects of earthquakes.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

LAST WILLS AND TESTAMENTS.

By JOSEPH W. SUTPHEN.

CAN a will of real or personal property be so prepared and executed as, barring questions of incapacity and undue influence, to be incontestable? Protracted and expensive litigation, frequently involving a period of years, often eating up large portions of estates, and finally resulting in the defeat of a testator's wishes, suggests this oft-repeated question. Considering the matter of execution first, nothing would appear simpler. Our statutory requirements are few and explicit, and, if properly observed, the inquiry, so far as execution is concerned, is easily answered. The provisions of the New York Revised Statutes are—

1. That the will shall be in writing, and subscribed by the testator at the end.

2. That such subscription shall be made by the testator in the presence of each of the attesting witnesses, or shall be acknowledged by him to have been so made to each of the attesting witnesses.

3. The testator at the time of making such subscription, or at the time of acknowledging the same, shall declare the instrument so subscribed to be his last will and testament.

4. There shall be at least two attesting witnesses, each of whom shall sign his name as a witness, at the end of the will, at the request of the testator.

These provisions are practically the same in most of the United States, with the exception, perhaps, of Louisiana, unless it be that some of the States require three or more in the place of two witnesses. An intelligent compliance with the above directions would seem in no wise difficult, yet many an intended will has proved an abortion, solely from lack of their observance, ignorance, and carelessness, and in some instances, no doubt, forgetfulness on the part of witnesses as to what actually transpired at the execution, explaining the circumstance. A witness's stupidity or forgetfulness can not easily be guarded against, except by the selection of intelligent witnesses. This sometimes, as in the case where the testator is *in extremis*, is impossible; but a stupid or forgetful witness to a will is a great misfor-

tune, for he may utterly destroy its value. Unless proof *aliunde* is obtainable, showing that the requirements of the statute were duly observed, there is great probability that the will will be rejected by the surrogate, and his decree sustained by appellate tribunals.

In November, 1850, an instrument, dated February 2, 1849, was offered for probate to the Surrogate of Kings County, New York, as the last will and testament of Thomas Lewis. It devised all his real and personal estate to his wife; but its probate was opposed by the heirs of the deceased. This document was signed in the proper handwriting of Mr. Lewis; it had two subscribing witnesses, while attached to the will and above the signatures of the witnesses was an attestation clause in the following words:

"The above-written instrument was subscribed by the said Thomas Lewis in our presence, and acknowledged by him to each of us, and he at the same time declared the above instrument so subscribed to be his last will and testament, and we, at his request, have signed our names as witnesses hereto."

On the contest, Ferris Tripp, one of the witnesses, swore that he was a clerk in the store of the deceased at the date of the will, and that Wing, the other witness, was also a clerk; that he (the witness) signed his name at the end of the attestation clause, at the request of the testator; that, on the occasion when he did so, Wing and he were called by the deceased into his private office, where he had a paper, of which he turned up so much as would allow them to write their names thereon, requesting them to sign the same and add their residences; that he also then said, "I declare the within to be my free will and deed"; that this was all that was said, according to his recollection, and that he and Wing then signed their names to the instrument where they appeared; that he did not then know to a certainty what the instrument was, but thought it a will from the fact that the deceased had that morning sent out and procured a blank will. On cross-examination this witness testified that at the time he signed his name to the instrument it was so folded or placed upon the desk that he saw no part of the contents, and that neither the same nor any part of it was read to him; that he did not see the testator sign it, nor did he see his signature to it when he signed as a witness.

The other witness testified in substance that he signed his name to the alleged will in the office of the deceased; that he was unable to say what occurred on that occasion, but that, according to his recollection, he signed at the request of the deceased; that he had no recollection that the deceased said anything else to him at the time he signed, unless it was "to see him sign the document"; that he did not recollect that the deceased signed the instrument in his presence; that he had no recollection that Tripp, the other witness, was present when he signed, and could not state anything further which occurred or was said or done by the deceased on the occasion. On his cross-examination he

further testified that he did not read nor was any part of the instrument read to him when he signed it, and that he had no recollection that he then knew what the paper was.

Here was an instrument which on its face met all the requirements of the law. It was in writing; it was subscribed by the testator at the end; it had two subscribing witnesses, and a full attestation clause. The testimony of Tripp and Wing completely nullified it; their want of recollection, although less than two years had elapsed since its execution, effectually prevented its probate. The probabilities are, that all legal technicalities had been observed, but the particular facts had escaped the memories of the witnesses. The surrogate adjudged it no will; the widow appealed to the General Term, which affirmed the decree of the surrogate, and then to the Court of Appeals, which affirmed the General Term (Lewis *vs.* Lewis, 11 N. Y., 220).

Ignorance and carelessness are even more reprehensible than stupidity or forgetfulness, and each has proved a prolific source of evil to testators' intentions, of expense to suitors, and of disappointment to apparent legatees. Assumption of the sufficiency of one's own knowledge regarding matters concerning which he has little or no information has caused the wishes of more than one testator to utterly fail, or ruined his estate in costly litigation. Books entitled "Every Man his own Lawyer," "Legal Directory," "Legal Remembrancer," are not, as a rule, the best fountains from which to quench legal thirst. Their accuracy is often subject to impeachment, and their pages have more than once proved to the layman a stumbling-block. Nor should relations complain of the courts if carelessness has led him into the execution of an instrument which proves either to be no will at all, or only such after much of his estate has been squandered to ascertain the fact. It is always wise to prepare and execute such a document in the leisure moments of life, for to do so *in articulo mortis* is a serious matter in more senses than one, concerning which a man should think twice, for, if he leave it until then, he will have little time to think at all. Mr. Gordon undoubtedly thought he knew how to draw a will well enough when he executed the following:

"Dear old Nance, I wish to give you my watch, two shawls, and also $5,000. Your old friend, E. A. Gordon."

After much litigation this was established as a will, but it is likely that "old Nance" was obliged to content herself with the watch and two shawls (Clarke *vs.* Ransom, 50 Cal., 595).

So, too, with Ehrenberg's will, who was the author of the following laconic testament—a model of brevity:

"Mrs. Sophie Loper is my heiress."

(Signature.)

Following which appeared:

"The legatee's name is correctly spelled Loeper."

To this there were no witnesses, the law of Louisiana requiring none. After ten years' litigation or controversy this was also sustained as a will (Succession of Ehrenberg, 21 La. Ann., 280). The sufficiency of the legal attainments of each testator in these instances, it is true, was enough, but to establish that fact old Nance and Mrs. Loper undoubtedly paid handsomely. In the following case the success of the would-be testator was not so signal:

In 1876 an instrument purporting to be the last will and testament of John Kelly was offered for probate to the Surrogate of the County of New York. It was partly written and partly printed, and was apparently a short form of will such as may be purchased at a stationer's. After disposing of his property, this document ran as follows:

"Likewise I make, constitute, and appoint Edward McCarthy to be executor, *J. Kelly*, of this my last will and testament, hereby revoking all former wills by me made. In witness whereof I have hereunto subscribed my name and affixed my seal the 24th day of July, 1874, in the year of our Lord one thousand eight hundred and sixty.

Witnesses:

EDWARD MCCARTHY,
DANIEL VAN CLIEF.

Subscribed by *John Kelly*, the testator named, etc."

When the deceased requested the witnesses to sign the instrument, the name *J. Kelly* had already been written by him where it first appears. The witnesses then signed it, and afterward the deceased wrote his name where it appears in the attestation clause. The point in dispute touched the first requirement of the statute: Was the subscription *J. Kelly* in the body of the instrument a "subscribing at the end of the will"? The subscription *John Kelly* in the attestation clause was, of course, bad, being made after the witnesses had signed. It appeared from the evidence that the testator presented the instrument to the witnesses, saying: "I drawed up a will for fear anything might happen me before coming back; in case there was any dispute about the trifle of money I have, I want you to witness this will." The name *J. Kelly* had been written in before this was said. The surrogate rejected the instrument, as not executed and attested in the manner prescribed by law. The General Term reversed his decree, directed that the will be admitted to probate, and that letters testamentary issue thereon (7 Huec, 290). The Court of Appeals then finally settled the law in the case by reversing the Supreme Court and setting aside the instrument as absolutely void (67 N. Y., 409). A curious circumstance in connection with the proof of this instrument is the fact that the Supreme Court were unanimously of the opinion that this document was a will, while the Court of Appeals were unanimously of the opinion that it was not! Even when, by a mistake in turning over the paper, the signature is put on the back of a blank

page occurring in the middle of the will, it can not be sustained (Heady's Will, 15 Abb. Pr., N. S., 211).

Instances might be multiplied to illustrate the serious consequences resulting from ignorance, carelessness, stupidity, or forgetfulness in the execution and proof of wills, but these are sufficient to emphasize the necessity of intelligence, accuracy, and forethought in the matter. Returning to the discussion of execution:

1. The will must be in writing, and subscribed by the testator at the end.

Apparently this is plain and concise enough, and adapted to the comprehension of a child, yet a long list of expensive appeals attest to the difficulty experienced in solving the meaning of this phraseology. What is writing? What is a signature? Where is the end of a will? are questions which appellate courts have been called upon to determine. If a will be printed; if it be done by a type-writer; if it be executed wholly in lead-pencil, instead of ink; if the signature be by a mark, or if it be made by another at the request of and for the testator; if the signature, as in the case of the will of *J. Kelly* (*supra*), be not immediately at the foot of the instrument—these and similar inquiries call for an answer to the *quære*, "Have the requirements of the statute been complied with?" It has already appeared that *J. Kelly's* will was not a will. The Court of Appeals, it is true, decided this case on other grounds than the single fact that the signature occurred before reaching the end of the document. Perhaps, if nothing of importance had followed the signature (McGuire *vs.* Kerr, 2 Brad., 244), the court would have sustained the decision of the General Term, and held the will to have been properly executed; but the fate of this instrument conclusively shows that it is not safe to tamper with a statute, and that the end of a will *is at the end;* in other words, the testator should have signed immediately above the witnesses, at the conclusion of the document.

Printed wills and wills executed by a type-writer have been held to be written within the meaning of the statute. On March 9, 1883, Judge York, at New Haven, Connecticut, admitted the will of James Willey, which was in type-writing, to probate, holding that the legal definition of writing included printing. The Supreme Court of Pennsylvania, in the case of Myers *vs.* Vanderbilt (1 Schuylkill Leg. Reg., 55), recently decided that ink was not essential, by recognizing as valid a will which was wholly written in lead-pencil and so subscribed. This agrees with the views of ex-Surrogate D. C. Calvin, of New York, who, in October, 1878, admitted the will of Henry J. Mann, otherwise and better known as the actor Montague, to probate. This will was written and signed wholly in pencil, upon a leaf torn from an ordinary diary or small memorandum-book, and was as follows:

"If anything happens to me, I make this my last will and testa-

ment in favor of my mother, who is to take everything I possess; in case of her death, then my sister inherits all my effects. L. Simon and Arthur Sewell I appoint executors.

H. J. MONTAGUE."

On the back of this scrap, also in pencil, occurs:

"Witnessed by T. R. EDWARDS,
LOUIS M. SIMON."

In cases of contracts, lead-pencil agreements have repeatedly been held sufficient (Merrit *vs.* Clason, 12 Johns., 102; Clason *vs.* Bailey, 14 id., 484; Brown *vs.* Butchers' and Drovers' Bank, 6 Hill, 443), and the same reasoning applicable to such applies also to testaments. It is certainly to be hoped that the tendency of the decisions in this respect will change. The door for the admission of fraud is here opened too wide. To erase and rewrite in the body of the will is much too easily and cleverly accomplished, and this temptation should be removed by statutory enactment or judicial interpretation.

A mark or cross has been held a good subscription. Some years ago Moses W. Jackson left a will signed—

his
MOSES W. × JACKSON.
mark.

The surrogate adjudged this sufficiently subscribed; the Supreme Court upheld the surrogate, and the Court of Appeals sustained the Supreme Court, holding that it was not even necessary that the words "Moses W. Jackson, his mark" should have been written *before* he made the ×. The law would undoubtedly admit the cross if the words were entirely wanting, under proper evidence (Jackson *vs.* Jackson, 39 U. S., 153). If the testator requests a third person to subscribe the will for him, and it be done in the presence of the witnesses, it comes within the statute (Campbell *vs.* Logan, 2 Brad., 90; Van Hanswyck *vs.* Wiesl, 44 Barb., 494). But such third person must himself also sign as a witness.

2. Such subscription shall be made by the testator in the presence of each of the attesting witnesses, or shall be acknowledged by him to have been so made to each of the attesting witnesses.

On December 1, 1865, William Baskin made a last will, and five weeks afterward died at the age of eighty-nine years. Thirteen years before he had made a previous will, which still continued in existence. At his death the will of 1865 was offered for probate to the Surrogate of Yates County, New York, but its admission was contested. The evidence showed that the last will was drawn by one Henry Smith on the morning of December 1, 1865, at the bedside of the deceased; that the whole was read over to him, clause by clause, and that Mr. Baskin at the completion of the reading sat up on the side of the bed and wrote his name at the foot of the will without assistance and

without spectacles. Mr. Smith then affixed his own signature at the request of the deceased, as an attesting witness. Mr. Wilsey, the other witness, was then called in from the adjoining room, when the testator said, "I want you to sign this will," Mr. Smith at the same time handing it to him. While still in Smith's hand, the latter asked the testator if he acknowledged it to be his last will and testament. He said "Yes." Wilsey then signed, when Mr. Baskin said, "That kills the other will." No conflict of evidence existed. Both witnesses agreed that the signature of the testator was affixed *before* Wilsey came into the room, and that Mr. Baskin did not expressly state in his presence that he had signed the will. The surrogate said this was no will, for it had not been *signed* in the presence of *each* attesting witness, but the Supreme Court reversed his decree, and the Court of Appeals affirmed the Supreme Court, holding: "Where the testator produces a paper bearing his personal signature, requests the witnesses to attest it, and declares it to be his last will and testament, he thereby *acknowledges* the subscription within the meaning of the statute" (Baskin *vs.* Baskin, 36 N. Y., 416). In fact, it is not even necessary that the subscribing witnesses should be shown the signature of the testator to the will at the time of acknowledging its execution.

In 1866 the will of Samuel Mott came before the Surrogate of Queens County, Long Island, for probate. It was contested upon the ground, among others, that it had not been signed in the presence of each witness, they signing after the testator but on different days, and that at least one of them had not so much as seen Mr. Mott's signature, the document being so folded when executed as to hide the name. The surrogate admitted it, however, the Supreme Court and Court of Appeals affirming his decision (Willis *vs.* Mott, 36 N. Y., 486; Hoystradt *vs.* Kingman, 22 N. Y., 372). So in the case of Ellis *vs.* Smith, decided in 1754 (1 Vesey, Jr., 11) by Lord Chancellor Hardwicke, assisted by Sir John Strange and the Chief-Justice of the Common Pleas and Chief Baron of the Exchequer, it was held that a testator's declaration was equivalent to an actual signing in the presence of the witnesses, a rule unchanged by the statute under consideration.

These cases show that considerable latitude is tolerated under this section, but that one of two facts must transpire in order to comply with its terms—either an actual subscribing by the testator in the presence of each of the witnesses before they sign; or a clear, indisputable acknowledgment to each of them that the instrument has been already so subscribed by him (Chaffee *vs.* Baptist Missionary Convention, 10 Paige, R. 85). Of course, in the latter case, if the subscription subsequently appears wanting, such acknowledgment amounts to nothing; there is no will.

3. The testator, at the time of making such subscription, or at the time of acknowledging the same, shall declare the instrument, so subscribed, to be his last will and testament.

Here, again, nice questions have arisen. What is a declaration that "this is my last will and testament"? Is it sufficient that the question be asked me and that I assent thereto by "yes" or a nod? If I say "This is my free will and deed," have I fulfilled the requirement, or must I use the precise words "This is my last will and testament"? These and kindred inquiries have perplexed the courts, and weary litigants have been forced to possess their souls in patience, awaiting the interpretation of blunders which could easily have been avoided in this particular of execution. The courts say it is not imperative that the word "declare" should be employed—I "acknowledge" this paper to be my last will and testament is enough (Seguine *vs.* Seguine, 2 Barb., 385). But a mere nod of assent to the inquiry, "Is this your last will and testament?" observed only by one of the persons present, is not enough (Burritt *vs.* Silliman, 16 Barb., 198), while an answer "yes" to the inquiry has been held sufficient (Coffin *vs.* Coffin, 23 N. Y., 9). To say "This is my free will and deed" is not good, for, as above appeared, the Court of Appeals has held that Thomas Lewis failed to acknowledge his will, although he used these particular words, and rejected his final testamentary disposition as a nullity. What apparently could be easier than to say "This is my last will and testament" at the proper time and under the proper circumstances? yet that many fail to either use these simple words, or to know the proprieties of time or circumstance, is shown by the foregoing cases.

4. There shall be at least two attesting witnesses, each of whom shall sign his name as a witness at the end of the will, at the request of the testator.

A will with but one witness is bad on its face—it is no will; it is a plain failure to observe an all-important formality, but questions "What is a signing by a witness?" "Where is the end of a will?" and "What constitutes a testator's request?" have been before the courts for determination. To answer the first two inquiries briefly, it is enough to state that the same rules which apply to the testator's signature and to the place of his subscription apply with equal force to witnesses. A witness's mark is good (Meehan *vs.* Rourke, 2 Brad., 385; Morris *vs.* Kniffen, 37 Barb., 336), and he should sign after the testator, immediately at the conclusion of the instrument. Concerning the third "inquiry" as to the request, some contrariety of opinion has existed as to what shall be deemed sufficient. The following cases are in point:

A request may be implied; it need not be in express terms, as, if the testatrix be told in the presence of the witnesses that they have come to witness her will, and she then bow assent and they sign it, it is a request (Brown *vs.* De Selding, 4 Sand., 10; Peck *vs.* Carey, 27 N. Y., 9). Handing a will to the witnesses, at the same time evincing a desire to have them sign it, is enough (Gamble *vs.* Gamble, 39 Barb., 373). But a mere request to sign, without in some way disclosing the

nature of the paper, is bad (Harris's Estate, 1 Tuck., 293). Such questions as, "Will you witness my will?" or "I want you to witness my will," if addressed to *both* witnesses, are good (Van Hooser *vs.* Van Hooser, 5 N. Y. Surr., 365), but bad if addressed to only *one* of them (Rutherford *vs.* Rutherford, 1 Denio, 33).

Touching the question of the formalities of execution, a word on *foreign* wills is in place. All wills of residents of this State executed in foreign countries in accordance with the laws of the country where executed, but not in accordance with the law of New York, and all wills of foreigners executed in accordance with the law of their foreign domicile, if not also in accordance with the law of this State, who die leaving no property situated or which afterward comes here, are not admissible to probate, not because they are necessarily illegal, but because the statute-book declares this to be the law. The importance of this provision must particularly commend itself to the mind of every citizen intending to make a will, and contemplating a visit beyond the jurisdiction of his own domicile. Sometimes an action in the Supreme Court to establish such succeeds; but who can be found willing to unnecessarily involve his estate in litigation to ascertain the validity of a will when it can easily be avoided? The surrogate has certainly no power to admit such wills.

In concluding this discussion on the execution of a will, it may properly be said that the instrument must be fully completed before death—that is, it must have been subscribed by the testator at its foot, in the presence of the witnesses, or the subscription so acknowledged; it must have been declared to them to be his last will and testament, and the witnesses must actually have signed it, at his request, for, if he die ere this is accomplished, there is no will (Vernon *vs.* Spencer, 3 Brad., 16). Simple as these statutory requirements are, the instances cited prove that even the question of execution is not free from serious snares. Yet a literal compliance with the formalities of the statute is not required, a substantial observance of them being sufficient (Coffin *vs.* Coffin, *supra*).

It is entirely possible to execute a will so as to be technically incontestable.

Touching the graver question as to preparing or drawing the will—in other words, considering its contents, whether its provisions offend the law or not—the scope of the inquiry broadens and becomes very comprehensive. It presupposes on the part of the draftsman a knowledge of the law as determined in unnumbered decisions adjudicated both in England and the United States. The common law, principles of international comity, and statute-books, all must be resorted to in answering the question. It assumes in the writer of the will an accurate and extended fund of information upon the subject of trusts, powers, and uses, and generally an intimate acquaintance with all the nice details relating to that great branch of jurisprudence—real estate.

It suggests a familiarity with laws past and laws present, and it means, if it means anything, that competent intelligence must guide the hand which guides the pen.

In view of these facts, there is small reason to complain at the litigation so frequently entailed in connection with estates. To prepare or draw a will is not the simple matter some imagine it to be, even when short and free from intricate questions of law. The slightest ambiguity in language, giving opportunity for dispute as to the testator's real intentions; ignorance of the legal effect of certain dispositions made in the instrument; wishes imperfectly expressed; illegible writing; erasures; interlineations, and circumstances similar in character, are all fruitful of evil consequences. The books are full of instances where instruments have been propounded as wills, but which have proved to be still-born, or, if initiated into existence as living, genuine wills, only so after the ordeal of many years' litigation to determine their genuineness, sufficiency, or construction, has been endured. Like surgery, law is a science. The unscientific man may with equal propriety endeavor to amputate his own limb as draw his own will. In each case he has ventured upon a field in which he has neither knowledge, experience, nor skill. He may succeed, but every probability points to a fatal result.

The antiquity of testaments is such that many imagine that to prepare and execute one is a matter of general information—one concerning which all are competent to speak. It is true that this mode of transferring title or ownership dates far back into remote ages. Writers assert that abundant evidence exists that wills were in use among the Hebrews in the earliest times. Plutarch speaks of their introduction by Solon into Athens, some six hundred years before the Christian era. The Twelve Tables gave to the Romans the right of *bequeathing* their property, a power which in England is coeval with the invasion of the Saxon, for no record or memorial exists of a period when this right did not obtain. But this antiquity proves nothing. Other sciences are equally old.

To prepare or draw a will can only safely be undertaken by him whose intelligence and experience have earned him the right to assume the task.

The subject of incapacity and undue influence is not embraced in this inquiry, but a word in reference to it may not be out of place. No will was ever yet drawn, nor can one be, which was or will be proof against attack from this quarter. That many have been disgracefully contested by shameless relatives is true; for, to forget such in his will, even if related to the deceased but in the remotest degree, is conclusive evidence to the minds of some that the sanest or most self-willed man while living has proved, in spite of all, weak and insane at death. Because contests frequently arise, however, from this cause, it does not follow that this is not at times a very proper ground

to take in resisting the probate of a will. To do so would be to fly directly in the face of the decision of Delafield *vs.* Parrish (22 N. Y., 9), where the question of incapacity was so ably and exhaustively presented to the Court of Appeals by Mr. Evarts, Mr. O'Conor, and other illustrious counsel. No one can fairly doubt, after reading the able opinion of the Court in that celebrated case, that Henry Parrish was incompetent to execute the last two codicils to his will. It is true he had been a keenly intelligent man; he had amassed a large fortune; he had never acted in life from impulse, for wisdom, discretion, and reflection prevailed in his counsels. Yet, after his paralytic stroke, he became a changed man. The quiet, urbane gentleman became a fretful invalid, forgetful of even the proprieties of life. Idiotic dementia took possession of his once-active brain. It was in this condition, and after the stroke of paralysis, that the last two codicils were executed. It should occasion no surprise that the courts utterly refused to receive them. Still, that much abuse of this objection to the probate of a will is prevalent, is undeniable. Nor does there seem to be any cure for the disease, unless the theory "*omne testamentum morte consummatum est; et voluntas testatoris est ambulatoria usque ad mortem*," be changed, and every man allowed to probate his own will before he dies, if he desire. Let him summon all who have the right to contest his ability, etc., to execute a will, and, if they do not appear, or if they do not succeed in showing his inability so to do, they shall be forever estopped from attacking the will thereafter. Of course, there are serious objections to this course, for all beneficiaries would then know the contents of the document, and few men care to let the world into the secret of their final intentions or ulterior purposes; still this law has been tried in some of the States successfully and satisfactorily. Whatever is contained in this paper on last wills and testaments applies with equal force to codicils.

FIFTY YEARS OF MECHANICAL ENGINEERING.*

By ABNER C. HARDING.

I WILL begin by referring to the steam-plant employed for manufacturing purposes. In 1832 the stationary engine was commonly the beam-engine, often condensing but seldom compounded. Steam was supplied by boilers having but little resemblance to the boilers which most of us are familiar with. The name given the boilers explains their form; they were variously called tun, hay-stack, balloon, elephant, chimney, and ring boiler, to each of which they severally bore a striking resemblance. They were built in utter disregard of all

* Read before the Peoria Scientific Society, March 24, 1883.

laws relating to the strength of material, but were well adapted for the convenience of the firemen, in that the flues were of such size that a man could pass through them to remove accumulated soot.

The result was, that the boilers were incapable of withstanding an internal pressure of more than four or five pounds to the square inch. The low pressure made a large cylinder necessary to secure the required power, and the size of the cylinder restricted the speed, which rarely exceeded 250 feet a minute. The boilers were commonly fed by a tank situated high enough to enable the water to overcome the pressure of the steam. The low pressure and slow piston-speed necessitated very large cylinders relatively to the power obtained. The consumption of fuel was about ten pounds to the one horse-power per hour.

The governing was done by slowly-revolving pendulum-arms scarcely securing centrifugal force enough to raise the balls and actuate the butterfly-valve in the steam supply-pipe, thus making a very poor and inefficient governor. The low speed made a very heavy fly-wheel necessary to secure uniformity of motion, also costly trains of gear-wheels to secure the rotative speed required for factory-work.

In 1882 the boilers are cylindrical, frequently internally fired, and, thanks to Sir William Fairbairn's circumferential bands, the flue, subjected to external pressure, is so strengthened that the danger of collapse is removed even with our present high pressures. The tendency of the day seems to incline toward the water-tube sectional type of boiler and a rational system of inspection and test. The pressures in use to-day vary from 80 to 150 pounds. The piston-speed is nearer 500 feet per minute, often 800 and 1,000. An engine of 1832 capable of exerting 25 one horse-power to-day would indicate about 250 working under fair conditions. The same expenditure of fuel to-day would give nearly four times the power.

The decrease in size of the cylinder due to the higher pressures has made higher rotative speeds possible; hence, the engine requires a much lighter fly-wheel, and the governing is made more effective. The most efficient engines of to-day are found in our city pumping-stations. Here the conditions are favorable for securing the highest economy, a duty of 100,000,000 foot-pounds being frequently secured. The engine of to-day for mill-use is, comparatively speaking, a portable engine requiring nothing but a foundation to bolt it to. The engine of fifty years ago was not self-contained or self-supporting, but required to be built from the ground up, and the support of walls and timbers.

To-day the practice is to make large engines condensing and often compound, expanding the steam in some instances ten volumes. The higher pressures and rotative speeds of to-day have made the use of high expansions possible in comparatively small engines, and economies are secured which, but a few years ago, would have been wonderful for large engines. The governing is done by quick-running governors which either throttle the supply-pipe or alter the point of cut-off,

and thus secure uniformity of motion with the highest expansive use of the steam.

In 1832 no steamship had essayed the passage across the Atlantic. The marine boilers of 1832 were unfit for resisting any considerable pressure, in fact, so weak were they that they have been known to collapse when steam had been let down. The engine and boilers took up so much of the tonnage of the vessel, and used such enormous quantities of coal, that it was predicted that it would never be possible to cross the Atlantic unaided by sail. In fact, the prediction held good for a long time, for transatlantic steamship lines were compelled to establish coaling-stations at Halifax and Queenstown in order to reduce the coal carried, and allow of a little cargo being taken on. In 1832 all hulls were wood, and salt-water was invariably used in the boilers, much to their injury. The speed rarely exceeded eight knots an hour.

In 1882 the ships are almost invariably of iron or mild steel, and this enables the introduction of an element of safety impossible with the use of wood : I refer to the compartment and cellular system of naval construction. The use of iron and steel has made the construction of ships of great length possible.

The boilers are of enormous strength, and carry from 80 to 125 pounds pressure. The cylinder or cylinders are now adapted to the economical utilization of all the expansive force due to the pressure used. To secure this, more than one cylinder, is used ; all the expansion could be had in one cylinder, but the difference in temperature of the cylinder, due to the temperature of the steam before and after expansion, would cause undue condensation. The substitution of the propeller for the paddle-wheel for sea-navigation and the high speeds required by the former have done much to reduce the size and weight of the marine engine ; and have also had a marked effect on the economy. The paddle-wheel has practically disappeared, except on rivers.

A piston-speed of 800 feet a minute is often attained in daily practice. Hence, enormous powers are secured with comparatively little loss of carrying-space.

The marine governor of to-day is almost endowed with prophecy. It anticipates the pitching of the ship and withdrawal of the screw from the water, and cuts off steam just before its occurrence, thus avoiding the dangerous racing of the engine when the screw leaves its work. This, for a long time, has been almost the only danger in bad weather ; the racing of the engines subjected the screw-shaft to strains for resisting which the shaft was inadequate. The twisting off of the propeller-shaft of an Atlantic steamer is not an uncommon occurrence. Condensation is now had almost in all cases by the surface condenser, thus returning all the water to the boiler to be used again. It might be well to speak here of a steamship built in 1882. Steamships are now making long voyages at a high rate of speed, voyages which till

a short time ago had been left to sailing-vessels. This steamship has some points of interest, and illustrates the most advanced ideas on steam-engineering as applied to the mercantile marine. The engines of this steamer are triple expansive, having one high-pressure, one intermediate, and one low-pressure cylinder, using steam at 125 pounds pressure, generated by boilers whose only peculiarity consists in the fact that they are capable of withstanding such a pressure. On trial these engines gave one horse-power for 1·28 pound of coal burned per hour. This would, according to the usual analogy, indicate a daily working efficiency of about 1·50 pound to the one horse-power. This steamer can carry coal for a voyage of 12,000 miles, and, with proper use of sails, could probably keep under steam for two months without coaling. The weight of the engine and boilers of 1832 was about 1,000 pounds to the horse-power; to-day it is about 300, and in some instances has been reduced to forty-five pounds to the horse power.

An English firm have recently completed a small light compound engine, which, in point of weight, eclipses anything heretofore built. This engine is made of steel and phosphor-bronze; all parts are built as light as possible, the rods and shafting and all parts possible being bored out to reduce weight. At a speed of only 300 revolutions a minute they indicate over twenty horse-power, and weigh but 105 pounds all told. This engine would give fully thirty horse-power actual at a piston-speed of 500 feet a minute. The size is three and three quarters high pressure, seven and a half low pressure, and five stroke. That thirty horse-power can be had from a proper utilization of steam and proper distribution of 105 pounds of metal is certainly most astonishing, especially so, considering that the engine is compound. A ship of 2,500 tons displacement was almost unknown fifty years ago; to-day the transatlantic steamer, the highest class of the mercantile marine, has from 8,000 to 13,500 tons displacement, and engines of 5,000 to 10,000 one horse-power. Several of the transatlantic liners have shown a mean ocean-speed of twenty miles an hour, and make the passage in less than seven days.

The present generation has grown so accustomed to the results of the progress of mechanical science that it has long ceased to wonder at its greatest works.

It may be well here to speak of the torpedo-boats which have been recently built for the English Government; they indicate the extreme limit of naval construction of this day. These little instruments of destruction are only eighty-seven feet in length, ten and a half feet in beam, forward draught eighteen inches, aft fifty-two inches, total displacement thirty-three tons. The engines are compound condensing, of the intermediate receiver type, high-pressure cylinder twelve and three fourths inches, low-pressure twenty and three fourths, stroke twelve inches, and indicated over 500 horse-power, with a gross weight

of only eleven tons, boiler, water, engine, condenser, propeller, and shaft included.

The special feature of the boat is the enormous power developed per hundredweight of propelling machinery. The boilers evaporate eighteen pounds of water per hour per square foot of heating surface, and 120 pounds of coal per square foot of grate-surface. This is fully six times the amount of water and coal usually dealt with per square foot of surface in furnace and boiler. Such a forced combustion precludes all thought of economy, yet a one horse-power is secured at full speed with an expenditure of three and a half pounds of coal. The forced draught is secured by maintaining in the stoke-hole an air-pressure corresponding to a column of water six inches high; this renders the stoke-hole quite cool and comfortable.

One ton of coal will last for a run of 100 miles at a ten-knot speed. A speed of twenty-two and a half knots has been secured in trials lasting three hours. This is a speed of 2,250 feet a minute, or thirty-seven and a half feet a second, and seems almost incredible.

But, remarkable and important as these results are in the phase of steam-engineering, these little vessels have revealed in their performances under speed-trials facts of equal importance to another department. The speeds attained are high even for large steam-vessels, but enormously high for such small vessels. It is found that passing the ten and twelve knot point, which bears about the same ratio to these little boats that eighteen knots an hour does to large steamers, the ratio of resistance to the speed decreases, and at the fifteen-knot point it is about the $3\frac{1}{2}$-power, at the eighteen-knot point about the 3-power, and sometimes at the twenty-two-knot point is as low as the $1\frac{1}{2}$-power of the speed.

Effort has been frequently made to utilize steam at much higher pressures than I have mentioned, but, owing to the solvent nature of steam or water at a high temperature, the results have not been satisfactory; among many difficulties encountered was that of lubricating the cylinders.

Loftus Perkins, an English engine-builder of prominence, is devoting much time to the use of steam at about five hundred pounds pressure, and with some success. Unfortunately, the gain to be anticipated from the use of these exceedingly high pressures does not seem to be very great on trial. The Anthracite, a small steamer fitted with engines and boilers specially adapted to the utilization of steam at five hundred pounds pressure, was more wasteful than many steamers using steam at one hundred pounds. However, here is a wide field and one that promises well.

Should the same change of law as to the resistance increasing as the square of the speed be found to hold good in large steamers as in the little torpedo-boats, we shall most of us live to see locomotive speeds at sea. There is now building in this country an engine which

will exert the greatest power as yet secured from one cylinder. The stroke is fourteen feet and the diameter of the cylinder is nine feet two inches, and the engine is expected to develop eight thousand horse-power. As an illustration of the size of the engine, the wrist-pin is almost exactly the size of a flour-barrel.

We now come to the engines and boilers used for railways. The year 1832 was the beginning of our present passenger and railway system on this side of the water, and, if the engines imported in that year to run on American roads are any indication of the state of the science of steam-engineering abroad, they could not have been much in advance. At this time the engine and boiler weighed about eight tons, carried forty pounds pressure, and could make about twenty miles an hour under light load and favorable conditions. The engine of that date could not pull more than three or four times its own weight, and had to stop at stations to fill boilers, as they could not pump while running.

The speed to-day is from forty to sixty miles an hour, and the engines weigh from thirty-five to eighty tons, and draw as high as eight hundred tons of paying freight in addition to the weight of the train. To-day the pressures run from one hundred and thirty-five to two hundred pounds. The latter pressure is used in Switzerland. The automatic and continuous breaks now stop a heavy train within four hundred yards at a speed of sixty miles an hour. Recent trials show that these breaks will absorb twenty miles of speed in one minute.

In 1832 the transmission of power was by flat tumbling-rods and cast-iron shafting of great weight and little strength. To-day we have smooth, light, rapidly revolving steel or iron shafting, supplemented and aided with rubber and leather belting where the latter will serve and the former can not. Where power has to be transmitted at a great distance, wire ropes, moving at a high rate of speed, are used. Wire-rope transmission commences at the point where the belt and shafting become too long or heavy to be useful. It is much cheaper than its equivalent of shafting or belting. In fact, a long line of shafting would cost more for oil in a year than a wire rope would in fifteen.

At the Rhine-fall, in Switzerland, eight hundred horse-power is transmitted a distance of two miles to a village where fifty small manufacturing industries, situated in every conceivable position relative to the cable-line, secure power. For ten years the cable street-railway system has been in use in San Francisco. The same system, slightly modified, is being adopted in many Eastern cities.

Fifty years ago compressed air had not been successfully employed in engineering, though its application as a blast to forges is coextant with history. Sir Henry Bessemer's steel process was made possible only upon the ability of engineers to furnish air under pressure in the converter. The importance of compressed air and the part it has taken in recent engineering undertakings can not be overestimated.

Without it the boring of most of our tunnels and the placing of masonry foundations under water could not have been accomplished. In 1832 the turbine wheel had just been invented, but not brought into use; in fact, hydro-mechanics has made as great steps forward in the last fifty years as any of her sister sciences.

A recent invention of Sir W. Armstrong deserves mention. A steam-engine actuating a pump is used to secure an artificial head of water, which water is afterward employed in driving various hydraulic motors operating cranes, lifts, driving riveting machinery, and the artificial head is secured by loading a ram of sufficient size with weight enough to place a pressure of seven or eight hundred pounds to the inch in the cylinder. The pumping-engine pumps against this ram, the chamber of which is connected with each of the machines requiring to be driven; whenever the work done in the various motors is less than the work of the engine, the surplus is expended in raising the ram, and when the ram is fully extended an automatic device stops the pump, which again resumes work on the withdrawal of water from the ram by leakage or use in motors. By the aid of this system of storing power, a small steam-pump attached to an accumulator is capable of furnishing three hundred or more horse-power for a short time. This arrangement is adopted in all docks and ship-yards of any pretensions.

Our modern turreted man-of-war handles its eighty and one hundred ton guns, and all the loading machinery, by the aid of similar hydraulic devices. These accumulators give an efficiency of ninety-eight per cent in practice, which amounts to perfection.

In 1832 rolled plates such as are now rolled were unknown, and the rolling of armor-plates twenty-two inches thick, weighing thirty tons, was not thought of.

The process of making wrought-iron by puddling has not changed much, though larger masses are handled. The manufacture of iron by puddling seems doomed; steel is taking its place rapidly; in 1832 masses of steel of over sixty pounds were not made; steel was dealt in by the pound for cutlery-use. Thanks to Sir Henry Bessemer and Dr. Siemens, steel is made on the Bessemer and open-hearth process, and in masses of many tons' weight. The rapid advancement made in engineering skill is due in a great measure to the cheapening of iron and steel making. Never in the history of the iron industry were there so many partially developed processes, the completion of which will revolutionize the industry, and furnish iron and steel at a cost much below present prices.

The unprecedented expanding of our railway interests since 1865 has had much to do with the development of the iron interests. Inventors of prominence promise us steel at one cent a pound, and in the light of the past it is not safe to assert that it will not be done. Steel rails have been sold within a few years at one hundred dollars a

ton; to-day they are worth thirty-eight dollars. It is confidently predicted by those who have made it a study, that the downward tendency can not be checked, and that one cent a pound will be reached as soon as the experimenters have worked out plans now in hand.

Considering the many improvements which are now proposed and tested, we can safely assume that the steel-plant of the future will differ widely from the plant of to-day. All the available heat and all the useful elements in the ore will be used. Briefly this is as follows: The ores, limestone, and fuel will be placed in the furnace, the molten metal will be run to converters, and there the foreign elements will be removed by a blast, the metal then recarbonized and cast into ingots, the ingots will be rolled into blooms, then the bloom into rails, and the rails will then be placed on small cars, and, while at a temperature of about 1,000° Fahr., will be placed in the flues of steam-boilers until they have given up about 700° Fahr., and then passed on as finished. The slag flowing from the blast-furnace will be placed on cars, and, while at a temperature of 3,000° Fahr., be run into the flues of other boilers used to generate steam for operating the blowers, rolls, etc. This, in brief, is one of the proposed steps in steel-making, viz., the utilization of all the heat in the coal, and afterward all the heat given to the iron and slag by the coal; by so placing the iron and slag as to give up their heat again to boilers used to generate steam for the roller-mills and blowing-engines, which in turn aid the smelting of the iron.

A rail-mill of 500 tons a day, at a low estimate, would secure heat to run a 1,000 horse-power battery of boilers from the cooling rails alone, and 4,000 horse-power in heat from the slag. Hence the steel-plant of the future will have no heating-furnaces, no gas-producers, no coal-consuming boilers, no cupolas, no ash-piles, and no fuel to be consumed except that required to melt the iron. The converter-slag can now be used instead of limestone by the new process. This, in brief, will be, it is confidently predicted, the new rail-mill of the immediate future. Everything is done by the aid of air, steam, and water. Muscle will be in little demand, brains at a premium. In 1832 cast-iron bridges existed of short span, but wrought-iron had not been used. To-day we think little of trusses of 500 feet span, and suspension-bridges of 1,000 feet; while it is proposed to build a steel truss-bridge over a mile long, with two spans of 1,700 feet each. In the power-printing press, an invention of the eighteenth century, we find that the last half-century has wrought wonders. In 1832 the best presses could turn out about 1,000 poorly printed sheets of printed matter; to-day, thanks to Hoe's revolving type and the processes of electro-plating and stereotyping, we have presses capable of printing 50,000 impressions an hour; and, what is almost as wonderful, it will number, fold, and stick together the whole. Such a machine costs about $100,000.

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We live in an age of progress. The additions to our knowledge made during the last fifty years seem to excel in utility and lasting benefits the knowledge acquired in centuries. Popular belief is that the possibilities of progress in all directions are unlimited. Those who should know, think that in mechanics we have nearly reached the limit which theory, well established, places before us. The steam-engine, using but one tenth of the power to be obtained from the coal, is nearer its limit than most people imagine.

The science of the future is undoubtedly in chemistry, and our great discoveries and greatest progress will be in that science. Mechanics may hereafter expect to take a secondary part. In the iron industry chemistry and mechanics have stood side by side; chemistry generally propounds the problems, pointing the way to the chemical solution, and calling upon mechanics to devise means for carrying out the undertaking.

One of the most notable features of modern industrial progress is the utilization of what has always been considered waste material. This is done by devising and constructing special machinery to meet the case. Sometimes costly experiments are necessary; but, in this age of speculation, those who gain the prizes offered in legitimate business are those who are willing to accept ventures involving large risks. There is no limit to human wants, and the industrial expansion we are engaged in will not be restricted except by the impossible.

Photography and the electric sciences are two arts of which nothing was known fifty years ago: what a gap the removal of one of these would make in our civilization to-day!

Sir Henry Bessemer's steel process has had a very marked influence on the mechanical advancement of the last half-century. Yet so closely allied are all the great steps in progress, that one can not be taken without the other, and Sir Henry was himself compelled to seek or invent numerous devices before his original steel process merited the name.

We daily complete engineering works which, in the amount of human labor they represent, far exceed the labor represented by the great Pyramid of Cheops. Undoubtedly the progress of the age, which is so largely engineering progress, does greatly increase the welfare of man. The forces of Nature now do the hard work, and the labor of the toiling millions is lightened many fold. The laboring-man now works with brain and eye, and his occupation is to direct and apply some principle of science. He now has time for improvement, comfort, and refinement; the forces of Nature having become obedient to the will of man, are made to produce for him not only plenty, but conveniences and luxuries formerly undreamed of.

A PREHISTORIC WATER-SYSTEM.

By M. A. LÜDERS.

THE canton of Valais, though not so much frequented by travelers as some of the others, is really one of the most attractive cantons of Switzerland, and possesses, in its Alpine heights and its temperate valleys, many beauties peculiarly its own. There are also many features worthy of notice in the customs and the economical devices of its population. One of the most interesting features of the latter class is its system of conduits for watering the pasturage and tillage lands. This canton, in fact, possesses the model system of water-supply in the Alps. The people have maintained it from primitive times, and have by it, during the whole period of their history, drawn the water from the glaciers and mountain-springs, to be applied directly to every part of their farms and garden-plots. Without such watering as it makes practicable, the production of the district would fall off one half. This was exemplified in the experience of some of the towns during the building of the Simplon road in 1802, when their canals were interrupted and their water-supply was cut off. The grass-crop was so greatly diminished that the number of cattle fell off to one fourth of what it had been, and the former productiveness of the fields was not restored till new canals were made in 1810. In the little town of Zenegger, also, the springs were dried up, in consequence of an earthquake in 1855, and the number of cattle that could be maintained was reduced from two hundred to fifty. New conduits had to be made for this place also, with much labor and at great expense.

The maintenance of the water-system of the Canton Valais is intimately associated with the communal and family life of the people. The water is brought down in wooden flumes, that have to cross precipitous clefts at hundreds of metres above the bottom. A watchman has to go over them daily, and sometimes at night. His pay is very small, and his office is rather one of honor, full of dangers, to which some fall victims in nearly every year. By an ancient prescription, no one can hold a public office till he has served for some time as a guard of the aqueducts. It is not unusual, when repairs are to be made in particularly dangerous places, to send a priest along with the workmen, so that, if any of them meet with an accident, they may be provided with the consolations of religion.

The water is drawn from glaciers, lakes, or reservoirs, springs, and melted snow. Glacier-water is best esteemed, and is preferred if it is turbid, for then it holds valuable mineral constituents; lake or reservoir water contains less of such matters, for they have settled. Spring-water is least in favor, because it is most deficient in mineral substances, and because the time it occupies in running down the conduits

is so short that it does not become warm enough to be used with advantage. The same objection is alleged against snow-water. The glacier-water, however, which is exposed to the sun for hours while running down the flumes, reaches the fields at an agreeable temperature, and ready for immediate application. This water is here free from oxide of iron, and is entirely fertilizing; but additional richness is sometimes given to it by carrying it around through the barn-yards, and making it the means for transporting manure directly to the fields.

The chief canals which bring the water down from the mountains vary in length from one thousand to fifty-five thousand metres; or, measured by the time it takes the water to run through them, from a quarter of an hour to six hours. The total length of the canals in the canton is one million five hundred thousand metres, or two hundred and fifty hours. The skill with which they have been located and constructed excites an admiration that is increased when it is remembered that they date from a remote antiquity and are the work of a simple country-people. Beginning often in the immediate neighborhood of the glaciers, crossing treacherous hills and lofty precipices, and spanning deep abysses, passing through tunnels and cuts, led along artificial terraces, that sometimes require additional embankments or walls to support them, these canals are really formidable works. They furnish the life-blood of civilization to the canton, and stand for a capital of incalculable value. They have been built and are kept up by the villages; and a badly kept one is an exception. In most of the valley-slopes they lie in groups of three or four, the uppermost one being the longest, and reaching far up toward the glacier-source, and have an average descent of about 0·5 per cent. The subordinate ditches are of a simpler character, till finally a mere mark on the ground is all that directs the water to the particular spot where it is wanted.

The application of the water begins at about the first of April in the valleys, and later as the height of the locality increases, till, on the highest cultivated grounds, it is delayed till the middle of June, and is continued for from two and a half to three months. The right to draw off the water is apportioned out by village officers into turns, of which there are from four to twelve in the season, of from eight to twenty-one days or more each, according to the number of land-owners claiming to share in it.

Among the most remarkable of the main aqueducts are those of the Gradetsch Valley, where the water is led down by eleven canals, the highest of which starts from an altitude of 2,300 metres, or nearly 7,500 feet above the sea. Some of the canals require wooden conduits three or four thousand metres long, that have at times to be supported by poles for six hundred metres at a stretch. To reach them for repairs the workmen have in some places to be let down the perpendicular rock-walls with ropes.

The oldest of the canals date unquestionably from pre-Roman times. The "Roth" Canal supplies three villages with water, and is 19,200 metres (more than eleven miles), or four hours and twenty-three minutes long. It starts from "La Plaine Morte" glacier, on the Weisshorn, 2,673 metres above the sea, crosses several clefts, is conducted through a tunnel more than three hundred metres long, is covered for 9,600 metres, exhibits other features of high engineering skill, has an average section of a metre and three tenths, and delivers nearly a cubic metre of water a second. An artificial lake, or reservoir, has been built in the same district, to hold the water that is not wanted for immediate use. Its water, however, has not the same value as that taken directly from the glaciers, because it has lost most of its mineral constituents by settling; but, as it has become thoroughly warmed, it is admirably adapted to those applications in which water is wanted simply to refresh vegetation, and make the soil more friable.

The villages of Ried and Bietsch have three aqueducts (Kehrwasser, Bietscherrinne, and Riederrinne), severally 8,400, 2,400, and 12,000 metres long, to bring down the muddy water from the great Aletsch glacier, which are led for long distances along vertical cliffs and over giddy chasms. At one point on the "Kehrwasser" three men have been killed, within twenty-five years, by falling into the gorge. The water of the Bietscherrinne issues foaming from a fearful-looking chasm. The canal, having a border formed of stones laid with sods, and masked by bushes from the Massa ravine that yawns beneath it, is safe to walk along at first. The bushes soon disappear, and the aqueduct becomes simply a wooden conduit, made of planks that have to be drawn to the place, and adjusted there with great danger, while the narrow, slippery gang-plank, which is the only walk, offers but the most precarious footing to one who has to look down through the high trestles or into the steep ravine of the wild Massa, on one side, while he must watch on the other side lest he hit his head against the overhanging rocks and lose his balance. The highest of the three canals, the Riederrinne, is distinguished from the others by its loftier rock-walls and deeper chasms. It reaches to the foot of the Aletsch glacier, and draws the water from its source. Near it may be seen older, abandoned canals.

Near where these three canals start is the Marjälen Lake, having its surface covered, even in summer, with floating ice. Its natural outlet is by the valley of Viesch into the Rhône, but occasionally, in seasons of extraordinarily high water, it overflows in the opposite direction, and pours its floods into the Massa, causing breaks in the canals and stopping the conveyance of water. The existence of the villages of Bietsch and Ried depends upon their obviating the mischievous effects of these overflows, and it is customary to give a pair of shoes to the mountaineer who first notifies the dwellers in the

valley of the occurrence of a break. A canal has been built to reduce the level of the lake, but it is not sufficient for the purpose.

The irrigation-canals of Lombardy and Lucca are more scientifically constructed, and display more technical skill, but they are not laid out on a more extensive scale than those of the Canton Valais. It is a fact deserving admiration that all of these colossal works have been and are still being built without the aid of technical knowledge, without any expensive instruments, by the people of the country; and that these people not only make great sacrifices of money and labor, but put their lives at stake, to assure themselves of a supply of water. Certainly a real struggle for existence is going on here; for, without a system of water-supply, there would be in many of the villages no grass, no vegetable crops, no corn, and no wine.—*Translated for the Popular Science Monthly from Das Ausland.*

WORKING CAPACITY OF UNSHOD HORSES.

By ARTHUR F. ASTLEY.

I SEND herewith a photograph of the near fore-foot of my *unshod*, white-hoofed, low-heeled chestnut horse "Tommy." This photograph was taken after I had driven the old horse (he may be twenty years old), in a phaeton, a hundred miles on hard roads in and around London. This does not include drives for exercise. It is impossible to say that the hoofs of this old horse (bought chiefly in order to test this question) are exceptionally good. The reverse is the case, as any of your readers, who may favor me with a call, shall see for themselves. That this animal, after having been for years "the victim of the farrier," should work, as he does, *barefoot*, is, I think, remarkable. As the old horse is nearly, if not quite, thorough-bred, he must have been shod (as is the vicious custom on the turf) very early; yet over all these evil influences, incidental to "the miserable coerced *shod* foot," the *unshod* foot has triumphed. *Shod*, my horse "brushed" and stumbled badly, but *barefoot* he does neither.

In Africa, a horse working in a post-cart does *barefoot*, over bad ground, twenty-four miles in two hours. In New Mexico, horses are ridden *barefoot* forty miles day after day, and perhaps twenty miles of this will be over a rough mountain-track. In Brazil, little horses (they seldom exceed fourteen hands) carry, slung across pack-saddles, *barefoot* (they have never been shod) *some thirty-two stone!* Thus loaded (or, rather, overloaded) they do twenty to thirty miles a day. Their journey may be some three hundred miles, and they load back the same. In England, *even race-horses* are shod! To gallop over a race-course, which no doubt may be hard at times, it is actually

thought necessary to shoe a horse! Here, where *weight* is of the very utmost consequence, the heels of the English race-horse must be weighted with plates! The *fact* that Marden, when he ran *barefoot* in the Sandown Derby on June 2, 1882, beat, in the deciding heat, his two shod opponents by three lengths (though in his first race with them that day Marden, *with his plates on*, could only dead heat them), such a fact as this weighs little with the horsey Englishman, who will still be found to set his thoughts or opinions against facts! After all that can be said as far as *argument* goes, he will still be found to prefer mere *assertion;* it will still be the "I *think* this," and "I don't *think* the other," with him! But then is not the horsey (and for the most part *untraveled*) Englishman, as a rule, in the language of "Freelance" in "Horses and Roads," "*energetically conservative*"?

Any one who will read this book will thereby much increase his knowledge as to the *real* capability of the horse's hoof. "Horses and Roads" was published in 1880, by Longman, Paternoster Row. I find quoted in it the saying, "An ounce at the heel tells more than a pound on the back." This explains Marden's success when, by removal of "plates," his heels were lightened for the deciding heat.

But many of our countrymen connected with horses, deeming themselves practical men, are too apt to think that they have, as Mr. Ransom ("Freelance") says, "gone into everything," and they may consider their knowledge as to the *real* capability of the horse's hoof complete. Now, is it complete? Is not shoeing horses very much a matter of *routine* with us? I will give two instances in order to prove this:

1. Some weeks ago I received a letter in which the writer said that he had been told by a veterinary surgeon that if a horse were worked barefoot his hoofs "would wear down to the quick *in a few hours.*" Now, I saw the other day a horse which has been doing the work of his master, a doctor, *barefoot*, not for "a few hours," but for *over five years!* During this time the horse must have traveled, shoeless as he is, some thirteen thousand miles over the not too good roads of the east of London, and often with a heavy brougham behind him. The hoofs of this horse are the admiration of veterinary surgeons, and they show no sign of undue wear. *This horse was unshod when eight years old.*

2. I recently saw a pony seventeen or eighteen years old, never shod, except for a short time when in the breaker's hands. This breaker shod the pony. This was done against the master's wish and

without his knowledge. The breaker was, I dare say, practical enough in *other* details of his calling, but, like the majority of his countrymen, he "had always seen horses shod, and he thought they always must be shod." The pony was sure-footed *without* shoes, but *with* them she nearly fell with her master as he rode her home from the breaker's. The shoes were taken off, and the pony did her work admirably without them for years. She has done plenty of work, for her owner tells me that he has frequently driven her, and also ridden her, *over* forty miles in the day. The saying, "One horse can wear out four sets of legs," does not, of course, apply to this pony. The application of this saying is to the *shod* horse, *whose every step is made upon iron.* As a writer has well said, "It is the *shoe*, not the *road*, that hurts the horse."

Now, we see that both veterinarian and breaker mistook the nail-lacerated, contracted, unused foot for the natural healthy foot. The former, raised off the ground with an iron ring called a shoe, and with the insensitive sole and frog pared away, is not (when the shoe is *first* pulled off) fit for contact with the ground. In such a case *time* must be given for the foot to *recover* before the unshod horse can be asked to *work* barefoot.

I have a cast of the off fore-foot of a mare belonging to Mr. Whitmore Baker. This cast was taken in December, 1882, after the mare had worked barefoot on stony, hilly Devon roads for *two years.* She was unshod in December, 1880, being then seven years old. This foot shows no signs of undue wear, and I shall be happy to show the cast to any one.—*Land and Water.*

HOUSE-BUILDING IN THE EAST.

IN England house-building is a matter on which, in spite of "jerry" builders, one can look with comparative equanimity. In Indo-China it is a very different affair. Everything that is a source of trouble in the West disappears in those comfortable latitudes. A site can be found practically anywhere. The jungle furnishes, for the trouble of cutting it, as much material as may be required. Comparatively so little skill is wanted to start as an architect that every man can be his own house-builder, and, if he is tolerably diligent and not too ambitious, might finish his house in a few days. But, as a set-off to all these advantages, it is a very difficult matter to raise up a house which is not rendered dangerous or ineligible by the nature of the soil, the idiosyncrasies of the surrounding spirits, or the revolutionary character of the timber used. Building houses is, therefore, a very critical operation, and not to be undertaken without very considerable Sabaistic lore and an intimate acquaintance with all the ani-

mistic peculiarities of the neighborhood. Otherwise the house-builder simply courts disaster, and may involve not only his own family, as well as himself, in overwhelming difficulties, but may actually render a whole district uninhabitable by his unwarrantable irritation of the spirits dwelling in the soil, in the air, and in the very logs of timber which are recklessly used, or are put up with an improper exposure to the south instead of to the north, or set in position at a time of year when presiding demons hold that such things ought not to be done. It is, however, a necessity, even of Indo-Chinese existence, that mankind should have houses to live in. For the instruction, therefore, of those who are forced by necessity, or are foolhardy enough to believe that they can build themselves houses without coming to any particular harm, there are elaborate text-books, both in Burmese and Siamese. The Burman Dehtton is a bulky treatise, containing a farrago of omens and signs with regard to all possible events and circumstances, and not merely to the process of building. The Siamese "Tamra," or "Manual of House-Building," is considerably more systematic, and, in addition, possesses the advantage that it sticks to the subject of which it professes to treat. The theories in both works are based on and elaborated from the Shastras which record the customs of the Brahmans. Notwithstanding their Buddhism, which prohibits all such beliefs, the Indo-Chinese have a very strong regard for the Brahmanical observances. They are much easier to comprehend, or at any rate more fitted to seize on the imagination, than the abstruse problems of the faith of the Buddha. Buddhist metaphysical positions are fine things to confound hostile controversialists with, but the common Indo-Chinese mind yearns for something more concrete. The house-building code is, therefore, a very popular institution. It persuades a man that he is pious when he has an internal conviction that he ought to be damned.

The first thing the would-be house-builder has to do is to find out the situation of the great dragon that encircles the earth with his body, like the Midgard serpent of Northern mythology. This must be ascertained before operations are begun at all, for it will have a great influence, not only on the time of beginning the building, but on the way in which the foundations must be dug and the method of hoisting the posts into position. This the Burmese have recorded for them in a rhyme which every school-boy can repeat. The Siamese are not less alive to the necessity of accurate information on the subject, and it is fully set out in the "Tamra." The reason of this is that when you come to dig the hole for the main post of the house you must heap up the earth on the side toward the Nagah's belly. Terrible consequences follow if you do not observe this preliminary precaution. If you should pile up your mound in the direction of the head of the dragon, your negligence or ignorance will involve the death of your parents, your brothers, and the patrons of your house.

To be without a patron in Siam or Cambodia is to get your name put down on the list of royal slaves. Insulting the dragon's tail is even more calamitous, for the tail is a most touchy member, and would as soon create an earthquake and ruin the whole township as not. The reckless builder who did such a thing would, therefore, be stoned out of the community as a public enemy. Touching the dragon's back is simple *lèse-majesté*. The lord of the house will soon find out his crime, but the knowledge will come too late. He will die. The belly is the only safe part. If you choose that quarter toward which to heap up your earth, then, subject to a number of other precautions to be mentioned, you are comparatively safe. It is to be observed, however, that you have only three months to do your digging in. The Nagah, for all that he is so testy, sleeps during that period, or, rather, it is the disturbing him in his sleep that causes all the mischief. When the quarter-year has passed he rouses himself, and shifts round to the next point of the compass, and there, like the Norway kraken, composes himself to sleep again. Digging operations must then be conducted according to the new rules. Still, the time allowed is not unreasonable. Even an average Indo-Chinese can dig a hole for a house-post in three months. When you have settled generally how you ought to dig, there are a number of special rules to be observed in the digging itself. It will never do to go blindly ahead, for all the world as if you were a navvy on piece-work. In the first place, it is well to dig at large all over the space your house is intended to cover. In fact, if you have any regard for yourself, you certainly will. There are divers reasons for this. If you find costly articles, silver or gold, or the images of men and deities, it is a most happy sign, and will go far to counteract all but willful remissness in other matters. On the other hand, when bones or ashes or the figures of wild animals are found, the deductions are most unpropitious, and, if you persist in going on, the house will have neither luck nor peace. If the remains of previous house-posts are found still lying buried in the ground, they must be carefully dug out and carried away, for if this were not done, and a new building were to be run up over the old remains, sickness and quarrelings would be the certain result.

In addition to such elementary rules, which are matters of universal knowledge in Indo-China, there are so many others that every one but a very self-sufficient person will submit his surface soil to the inspection of a regular professional man, an expert in the science of foundation-digging, before he makes a final decision. For example, though it is undoubtedly most lucky to find silver or old bricks in your excavations, you may at the same time come upon a colony of ants or other living creatures settled upon the spot. It is one of the fundamental rules of Buddhism that the breath of no living thing is to be taken, and to dispossess them is not by any means a creditable proceeding. Moreover, irrespectively of this objection, ants can bite through even

sun-toughened skins, so that there is a direct personal argument to support the sentimental objection. Then, again, you may find lead in your soil-turning. There is not the smallest hesitation in the books on a question like this. If you go on and build you will lose slaves and goods. But, for all the lead that is there, the turned-up earth may smell of beans, or may have the fragrance of the sacred lotus itself. This is a most happy omen. The dwellers in a house raised on such land will be most fortunate, and the soil round about is the best possible for cultivation. In such a dilemma there is nothing for it but to call in a Sayah and pay him to work out the problem, to make a resolution of forces for you. There are certain amateur ways of arriving at a conclusion by means of split bamboos and heaps of paddy, but they are apt to be fallacious and afford no real satisfaction to a well-constituted mind. It is not surprising to be told that sand is not a good foundation on which to raise a house, or that a soil which is mainly composed of small stones is undesirable; but when it comes to the slope of the ground, or the friability or stiffness of the earth, none but a thoroughly reckless man will trust to his own unaided intelligence.

At any rate, whether you get the advice of an expert or not, it is imperative that you should carefully turn over all the ground where the new building is to be. Having done this, it is a matter of reasonable precaution to make offerings to the earth-spirit. Acquaintance with this Phra Phum and his belongings is no light matter, and is likely to be as good as an annuity to the man who has mastered the details. As he is an earthy spirit he is especially liable to mortal failings, and notably possesses a very short temper, which will brook no deficiency in reverence. It will not do to be ignorant of the names of his father and mother and of his nine children. Forgetfulness of his possessions is equally likely to cause trouble. There must be no hesitation as to the proper titles of his house and the tower on it, his cattle-shed, his granary, his bridal chamber, his thrashing-floor, his lands, his garden, his monastery, and his three chief servants. Remissness in any one of these particulars is apt to make an offering dangerous rather than otherwise. This offering, by whomsoever brought, must be set down at the extremity of the toes of the Phra, who thereupon graciously takes up his broom and sweeps the place clean, and gives the pious votary his blessing. If an ignorant or presumptuous man should place his gifts near the head, the earth-spirit would curse him with terrible imprecations, and brush everything away, worshiper and all. Negotiations with this deity are therefore rather ticklish work, but it is perilous to leave them undone. The site being settled, and things made right with the guardian spirit of the earth, the next thing to be done is to dig holes for the reception of the posts. It is necessary to begin with that for the chief post, and the hole for this must not be dug square, but in the form of a triangle. This may imply more work, but that can not be helped. When the hole for the

main post is finished, go on with the others, but be sure to do it in regular order, working round in circles from right to left, so as to follow the line of the dragon's body from head to tail. When it comes to the hoisting of the posts into position, the face must throughout be turned toward the back of the Nagah, a little inclining toward the tail, and the post must be heaved up toward this point of the compass. Thus in the first three months of the year you must face west-south-west, and haul up the beam from the northeast, and so on for the other quarters. It is also necessary to be very careful in the selection of the timber for the house. Trees especially to be avoided are those which have no flowers, those which have no leaves, trees which grow on ant-hills, trees with birds' nests on them, and those from which the bark has been torn off from whatever cause. Unhappily these distinctions are not obvious in timber which you have not cut yourself, and rascally Chinese carpenters will not hesitate to palm off upon the unwary wood from a tree on which scores of egrets—the Byeing, or sacred paddy-bird of the Talaings—have nested. Chinamen in their way are nearly as unscrupulous as Manchester piece-goods manufacturers, and have as little regard for the comfort and ultimate opinion of their customers. The beams for the house must all be measured with the standard of your own hand. This, however, is a detail which hardly needs to be strongly urged in a country where the three-foot rule is unknown. After you have got the posts up, the surface of the ground must be smoothed down, and then the posts are decorated with little bags of shells, coins, husked rice, and the like. These must be hung up by the hands of a maiden, and not by any rude male. The heads of the posts are also covered over with cloth, for the safe keeping of the guardian spirit of the house. It would be neither seemly nor safe to leave him exposed to the elements. The final ramming in of the posts is done at an hour fixed by the astrologers, the culminating point of some happy constellation. There is much shouting and feasting on the occasion.

With the foundation of his house settled satisfactorily, the sensibilities of the great world-dragon and the guardian spirit of the earth soothed and conciliated, and the house-posts raised and decorated with proper profusion, the house-builder may consider himself past all his troubles. If anything has been done wrong, it is now too late to repair the error. If everything has been carried out in seemly and orderly fashion, he may deem himself particularly fortunate. The putting on of the roof and the fitting up of the plank or split bamboo matting walls is a simple matter, and may be done according to the light of nature and with what dilatoriness and adornments the builder pleases, so long as he does not depart from the mundane laws of use and wont and infringe upon the sumptuary regulations. That is even a greater offense than flouting the great Nakh, or setting up posts in defiance of the angel of the soil. It certainly meets with swifter

and more obvious, if not more exemplary, punishment. "There are two chances in the stare of a demon," says the Burmese proverb, "there is none in that of a king." One formality, indeed, remains, which is often omitted, it is true, but which no man of well-ordered mind should fail to observe. It relates to the setting up of the stair, or rather ladder, by which the house is entered, all the dwellings in Indo-China being raised off the ground on piles. If this stair is turned to the south, let a cat be the first living creature to ascend. If you manage this, then you will always have abundance in your house. The difficulty is to make the cat see the matter in the same light. If your steps face the west the question is simpler. All you have to do is to take some iron in your hand along with a few lotus-leaves and a wisp of kaing, or elephant-grass. Everything you attempt will thereafter come easy to you. A cock should crow at the top to inaugurate the stair ascending on the north side of the house. This also is a matter likely to keep you out of your dwelling for a long time if you persist in waiting for it. Stairs never ascend from the east, for the same reason that no Buddhist should sleep with his feet pointing to that quarter. It was from the east that the Lord Buddha came, and it would be scandalous to show to that quarter a disrespect that would entail severe punishment if it were exhibited toward the king or a great man. It will hardly be necessary to mention that there is only one set of stairs and one entrance to the house, if built according to the national model.

It will thus be seen that, though a wooden house or a walled hut does not seem to imply much expenditure of time, labor, or capital in its construction, yet, in reality, what with the perplexing rules to be attended to, the dangers to be avoided, and the spirits to be propitiated, the Eastern house-builder has emphatically a hard time of it, and is not to be envied by Westerns who have no greater grievances than damp walls, defective drainage, perpetual draughts, and chimneys that will not draw.—*Saturday Review.*

SKETCH OF SIR CHARLES WILLIAM SIEMENS.

IN a paper giving an account of the British Association of 1882, of which Dr. Siemens was president, Professor Emil du Bois-Reymond referred, with some expressions of admiration, to the many ways in which the name of Siemens is identified with the most important of the recent advances in technical science. What Krupp is among German industrials in warlike arts, he said, the collective name of Siemens is in the arts of peace. Siemens telegraph wires gird the earth, and the Siemens cable-steamer Faraday is continually engaged in laying new ones. By the Siemens method has been solved the problem, by the side of which that of finding a needle in a hay-stack

is one of childish simplicity, of fishing out in the stormy ocean, from a depth comparable to that of the vale of Chamouni, the ends of a broken cable. Electrical resistance is measured by the Siemens mercury unit. "Siemens" is written on water-metres, and Russian and German revenue officers are assisted by Siemens apparatus in levying their assessments. The Siemens processes for gilding and silvering and the Siemens anastatic printing mark stages in the development of those branches of industry. Siemens differential regulators control the action of the steam-engines that forge English arms at Woolwich and that of the chronographs on which the transit of the stars is marked at Greenwich. The Siemens cast-steel works and glass-houses, with their regenerative furnaces, are admired by all artisans. The Siemens electric light shines in assembly-rooms and public places, and the Siemens gas-light competes with it; while the Siemens electro-culture in greenhouses bids defiance to our long winter nights. The Siemens electric railway is destined to rule in cities and tunnels. The Siemens electric crucible, melting three pounds of platinum in twenty minutes, was a wonder of the Paris Exposition, which might well have been called an exposition of Siemens apparatus and productions, so prominent were they there. It is a rare phenomenon when a whole family becomes so distinguished by eminent talent in a particular field of activity as the four Siemens brothers have been. They all seem to share their peculiar talent in a nearly equal degree, and to use it for a common purpose; and so heartily have they assisted each other that in the list of their inventions it is often hard to draw the line between what shall be accredited to one, what to another of the brothers. They all worked so harmoniously together, says the biographer of Sir William in the London "Times"—"the idea suggested by one being taken up and elaborated by another—that it is hardly possible to attribute to each his own proper credit for their joint labor. The task, too, is rendered all the harder by the fact that each brother was always ready to attribute a successful invention to any of the family rather than to himself." William was most appreciated in England because he lived and worked there; Werner, in Germany, because there was his home and field of activity.

Charles William Siemens was born at Lenthe, in Hanover, April 4, 1823. He received his early education at the "Catharinum," in Lübeck; then studied engineering in the Polytechnical School at Magdeburg; and in 1841 and 1842 studied in the University of Göttingen, where he enjoyed the instructions of Wöhler and Himly. Having finished his academical career at the age of nineteen, and displaying already some of that inventive faculty by which his brother, six years older, was distinguished, he entered the engine-works of Count Stolberg, where his attention was directed in the line of the practical applications of science to industry. He and Werner having devised an improved process in electro-plating with silver and gold,

William went to England in 1843 to dispose of the invention. In his lack of knowledge of the strange land, and his ignorance of our language, he made his first visit to an undertaker, thinking that he must be the proper person to take up, or "undertake," and push the new application. A call upon Mr. Elkington, who then controlled the gilding industry in England, was attended by a more satisfactory result, and Siemens went home so well paid for his trouble that he came back the next year with his chronometric regulator for steam-engines. This invention was less successful, commercially, than the other had been, but it made Siemens known to the engineering world, and it has been applied to the regulation of the great transit instrument at the Greenwich Observatory. The process of anastatic printing, another of the earlier inventions of the brothers, was made the subject of a lecture at the Royal Institution, by Faraday, in 1845. It is worthy of remark that the last lecture by Faraday at this Institution was on the advantages of the Siemens furnace. Another of the inventions of this period was the water-metre, which, according to Sir William Thomson, "exactly met an important practical requirement, and has had a splendid thirty years' success." The adoption of England as his home by William Siemens was determined by the fact that he found the patent laws of that country more favorable to the inventor than those of his own land.

Turning his attention to finding means for recovering the heat which is allowed to go to waste in engineering and manufacturing processes, William Siemens constructed a four horse-power steam-engine with regenerative condensers, which he set up, in 1847, in the factory of Mr. John Hicks at Bolton. This machine failed to become commercially successful; but Mr. Siemens, continuing his studies in the same direction, and having become acquainted and impressed with the dynamical theory of heat, read a paper before the Institution of Civil Engineers in 1853, "On the Conversion of Heat into Mechanical Effect," for which he obtained the Telford prize. In this paper he defined a perfect engine as one in which all the heat applied to the elastic medium is consumed in its expansion behind a working piston, leaving no portion to be thrown into a condenser or into the atmosphere, and advised that expansion should be carried to the utmost possible limit. Two years afterward he exhibited two steam-engines, with regenerative condensers, at the Paris Exhibition.

The greatest of the inventions with which the name of Siemens is associated is that of the regenerative furnace for glass-making and metallurgical operations, which he worked out in connection with his brother Frederick, who was also his pupil. By its means the defects of the discharge of the products of combustion at a very high temperature, and in an incompletely combined state, are remedied; a nearer approach is made to saving and applying to the work all the heat which the combustibles are capable of affording; a very high temperature is

attained, and steel is produced on the open hearth. Having matured his process at his experimental works in Birmingham, he laid the foundations of an industry which has attained a very great development in England, and lies at the base of extensive factories all over the world. The application of the principle of the regenerative furnace has been extended to numerous industrial purposes in which great heat is required; for the powers of the furnace are limited in practice only by the nature of the materials of which it is constructed. For the kind of services exemplified in this invention the Society of Arts awarded to Dr. Siemens, in 1874, its Albert medal "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the arts, and for his improvements in the manufacture of iron, and generally for the services rendered by him in connection with economization of fuel in its various applications to manufactures and the arts." Only a week before his death, the Council of the Institution of Civil Engineers awarded him the Howard quinquennial prize, which had been previously awarded only to Sir Henry Bessemer for a similar meritorious service.

Sir William Siemens and his brother Werner have co-operated in electrical invention, beginning with the Siemens armature, which they introduced about twenty-five years ago. The brothers, with Mr. Halske, of Berlin, established the Siemens telegraph-works in London, whence the most important telegraph and cable lines in the world have been supplied, and where valuable improvements have originated. The house has constructed four transatlantic cables—the Indo-European line, the North China Cable, the Platino-Brazilian Cable, and others. The want of a suitable vessel had been a serious difficulty in laying the long cables across the Atlantic, and Dr. Siemens had the Faraday constructed, with novel features that made it admirably adapted for its work. In 1860, while experimenting with the Malta and Alexandria Cable, he devised a pyrometer for measuring temperature through the amount of resistance developed in conductors by increasing heat. In 1867 he read before the Royal Society a paper on the conversion of dynamical into chemical force, at the same meeting at which Sir Charles Wheatstone announced his simultaneous discovery of the same principle, while Mr. Cromwell Varley had applied for a patent embodying the idea. Subsequently the Siemens dynamo was developed. We next find Dr. Siemens's name associated with the electric light, electric railways, and the electrical transmission of power. A fine illustration of the latter application is given by the Portrush and Bushmills Railway in the north of Ireland, opened last September, where passengers are carried on a line six and a half miles long of steep gradients and sharp curves "at a good ten miles an hour," solely by the water-power of the river Bush, applied through turbines to a dynamo at a distance of seven miles. At his own residence, near Tunbridge Wells, "not only did electricity perform a large part of the

actual work of the farm, sawing wood and pumping water, but it was made to supply in part the place of the sun itself, and assist the growth of plants and fruits."

The latest research having a practical bearing, with which Dr. Siemens's name is associated, was that which had for its ultimate end economy of the fuel used in domestic consumption and the abolition of smoke. With these purposes he was studying plans for extracting the gas from coal, and burning the gas and the coke separately, with a promise of successful realization which Sir William Thomson has well indicated in relating an incident that happened on the day of Dr. Siemens's death. On the 19th of November Sir William was accosted in a manner of which most persons occupied with science have not infrequent experience; "Can you scientific people not save us from these black and yellow city fogs?" The instant answer was: "Sir William Siemens is going to do it; and I hope, if we live a few years longer, we shall have seen almost the last of them." An apparatus which he had devised for the application of his plan to steam-machinery was to have been set in operation at the end of November.

Another research in which Dr. Siemens was engaged, all theoretical, was into the manner in which the solar heat is kept up; and he sought to show that, as in his own regenerative furnaces, none of the heat is lost, but that all is kept alive in some form, ultimately to be returned to the sun and to renew its energies in perpetuity,

One of Sir William Siemens's biographers well says of him that, in whatever direction he turned, his thoughts seemed to perceive new methods of working out old problems, or to discover new problems which it immediately became his province to solve; and it is said to have been a common saying in his workshops, that as soon as any particular problem had been given up by everybody as a bad job, it had only to be taken to Dr. Siemens for him to suggest half a dozen ways of solving it, two of which would be complicated and impracticable, two difficult, and two perfectly satisfactory.

Sir William Siemens was not a voluminous writer, but thirty-five papers are attributed to him in the Royal Society's catalogue of scientific papers, published in 1873. He has done much since, which is probably represented by literary results. His last public lecture was delivered March 13, 1883, and was on "The Electrical Transmission and Storage of Power." He was fully supplied with honors and titles, scientific and civil, and was a member of numerous learned societies.

Sir William Thomson says that "in private life, Sir William Siemens, with his lively, bright intelligence, always present, and eager to give pleasure and benefit to those around him, was a most lovable man, singularly unselfish, and full of kind thought and care for others."

Dr. Siemens died on the 19th of November last, of ossification of the heart, in connection with the results of a fall which he had suffered on the 5th. His funeral was held in Westminster Abbey.

CORRESPONDENCE.

THE AGE OF TREES.

Messrs. Editors:

HAVING been a regular reader of "The Popular Science Monthly" from its commencement, I have, of course, noticed the various articles having reference to the value of the concentric rings in determining the age of trees which from time to time have appeared in its columns, the last of which, in your August issue, induces me to give you the result of my observations upon this subject. I have had my attention directed to it during a residence of over forty years in Florida, during which my views as to the value of the rings in determining the age of trees have undergone a change. For the first few years my efforts were directed toward securing a grateful shade for the streets of the city of Jacksonville, and for this purpose the water-oak was selected on account of its beauty, symmetry of form, and rapid growth. And now the appellation of "Forest City," applied to it by visitors, is in no sense inappropriate, for many of the older trees have attained a size which in the State of New York, whence I came, would have required a hundred years to reach. Strangers from the North are apt to overestimate the age of our trees, and the number of rings presented appears to confirm in many instances the correctness of their estimate. When first called upon to account for the discrepancy shown by the rings, and the known age of the tree, I was perplexed and at a loss to find a satisfactory solution of the problem. But, having from my first arrival here kept a careful record of the weather, an analysis of my tables, a comparison with the record made by Nature on her infallible tablets in the trees furnished me the key to it.

Here, as well as at the North, the cold of winter puts a stop to vegetable growth, and in all exogenous trees a concentric ring will be formed, embracing all woody matter deposited since the preceding stop to its growth; but here in this climate causes are in operation that frequently produce as complete a stop to vegetable growth as does the cold of winter.

Our spring begins in February, when growth commences a new deposit between the bark and wood, but often (not always) there comes so severe a drought during late spring and early summer as to produce as full and complete a stop to vegetable growth as does the cold of winter; immediately after comes on our rainy season, generally about the middle or last of June, producing a rapid and luxuriant growth, which continues until winter again puts a stop to it. Our rainy seasons, however, do not consist of deluges of rain that overflood the country, but of daily showers, occurring in the early part of the afternoon, lasting an hour or two, leaving the sky bright and clear, the air cool for the rest of the twenty-four hours, comfortable to man, and favorable to luxuriant vegetable growth. The rainy seasons, when regular, continue day after day, for about sixty days, but often there is an interval of clear, sunshiny weather, for about a fortnight, between the rainy periods, which carries the rainy season into the fall months. Upon examination of the tree, it will be found that, when those severe droughts have put a stop to vegetable growth, a concentric ring well defined has been produced, and the growth which has occurred during the rainy season and until winter's cold has formed another and perhaps a thicker ring, making two rings in one year. But the phenomena of such a year are not necessarily repeated each year, for considerable variation occurs.

What physiological meaning is attached to these rings? They simply mark the amount of growth of woody matter deposited day by day between the periods when a stop to vegetable growth has prevented daily deposit and produced a line of demarkation, whether from drought of summer or cold of winter.

For some two or three years before his lamented death, Professor Jeffries Wyman was exploring the mounds of Florida. It was my privilege to enjoy his acquaintance and learn his views on matters of science in which we were both interested. I have heard him express his belief that he had reached an approximate age of some of the mounds which he had explored, by the indications which the trees growing upon them had furnished. It so happened that we were one time walking down-town together and passed a lot where preparations for building a dwelling-house were going on, and a tree which stood upon the proposed site was being cut down. He remarked that it was sacrilege to cut down so noble a tree; he would have changed the site of the house and let the tree remain as a shade, "for," said he, "it would take a hundred years to produce such another tree." In that, I told him, he was mistaken, as I knew the age of that tree, and it was not yet thirty years old. "Impos-

sible!" said he, and proposed, as the tree had been felled and lay on the ground, to go over and count the rings, to which I assented, and looked on while the professor undertook the task. I soon saw that he was under considerable perplexity. He said he found it no easy matter, as some of the rings were so indistinct that he was unable to decide whether they were single or double, "but," said he, "I can make out thirty or more, but how many more I will not venture to say." I carefully examined the rings, and saw what I had seen before. I have no doubt that at least forty rings could have been identified by a close and critical examination. I reiterated my statement as to the real age of the tree, for thirty years before I had seen corn growing on this spot.

I told him the tree which he had just examined presented a true record of the weather, so far as drought and rainfall were concerned, since it had been a tree, and invited him to call at my office and examine the records which I had kept during the same period, and he would find a confirmation of what I had stated. "This theory," says he, "is new to me, but it is plausible, and the facts here presented seem to substantiate it." His death, after his return North that year, put a stop to further scientific investigations in Florida on his part, but the reasons then given have induced many others to change their views as to the value of concentric rings in determining the age of trees. In a climate like that of Florida they certainly are not to be depended on; how it may be in a more northern latitude I will not undertake to assert or deny, but it seems to me probable that any arrest of growth, from climatic or other causes, will be indicated by some peculiarity in the formation of the concentric rings of the tree; and it may in some instances present two rings instead of one to mark an entire year's growth.

Very respectfully,

A. S. Baldwin, M. D.

Jacksonville, Fla., *September* 27, 1883.

BIRTH-RATE IN A NEW HAMPSHIRE TOWN.

Messrs. Editors:

While preparing a history of Chesterfield, Cheshire County, New Hampshire, the writer has had occasion to collect the birth-records of several hundred families, including both original settlers and their descendants. These families may be regarded as typical New England families, the original settlers having come, for the most part, from Massachusetts, Connecticut, and Rhode Island. The foreign element has always been very small in the town. A careful inspection of the birth-records in question (taking into account the children of *one* marriage only, in cases in which the father married more than once, and excluding the still-born) yields the following results:

1. The total number of births in 165 families, from 1750 to 1810, was 1,359, or an average number of $8\frac{1}{3}\frac{3}{3}$ to each family.

2. The total number of births in 328 families, from 1810 to 1870, was 1,825, or an average number of $5\frac{1}{3}\frac{8}{3}\frac{2}{3}$ to each family.

3. The average number of births in 140 families, from 1810 to 1840, was $6\frac{1}{3}\frac{3}{3}$.

These figures show that there was a marked decrease in the birth-rate of Chesterfield families between 1810 and 1840, and that in the period of sixty years, from 1810 to 1870, this decrease was still more marked.

If what is true of this town, in this respect, is also true of the majority of New England towns, as is quite probable, it would appear that the birth-rate in New England families has steadily decreased since the introduction of railroads and the extensive establishment of manufactories.

O. E. Randall.

West Chesterfield, N. H., *September* 3, 1883.

"TIDAL ANOMALIES."

Messrs. Editors:

In the January number of your journal there is a communication under the above-named title, from G. W. Grim, of the bark Coryphene. Referring to a proceding letter of mine, he says of my article, "After demonstrating, as a result of Professor Schneider's theory, a great inequality in the daily range of the tides," etc.

The gentleman entirely misconceives the purport of my criticism. I showed that Professor Schneider's theory is demonstrably false, and my reference to the New York tides was merely to show by them that the theory does not conform to the facts. The "daily inequality" is easy to explain: most of those given by Mr. Grim present no difficulty at all—with others, when the *facts* are established, the explanation will follow.

No theory of the tides is of any value except as based on facts—in which respect Mr. Grim's theory is worse off than Mr. Schneider's. A theory of the tides resting solely on one's inner consciousness is not a valuable contribution to knowledge.

R. W. McFarland.

Ohio State University, *December* 27, 1883.

CARRYING-POWER OF FLUID CURRENTS.

Messrs. Editors:

I see that in your November number, page 95, Mr. Carter applies the "law of carrying-power of currents" ($R \propto v^6$) to *blood-currents* carrying waste matter. Now, I make no objection to the general correctness of Mr. Carter's conclusions, but I am

sure that this is an entire misapplication of the law.

The fact is, this law is so often misunderstood and misapplied that it becomes dangerous to use it without clear conceptions of its nature. By many good hydraulic engineers it has been confounded with the law of *erosive power* of currents; by others, with the quantity of material carried *in suspension*; and now Mr. Carter confounds it with quantity of matter carried *in solution*. It were well if, *in popular language*, the name of the law were changed. Perhaps it would be less liable to be misunderstood if it were called "*lifting-power of currents*." It expresses only the *size* of the *largest transportable particle*. It is a law which concerns mainly the *geologist* and the *ore-dresser*. The geologist finds certain bowlders scattered about in the lower part of a valley. The question is, Were they brought by currents; and, if so, what was the velocity? It is applied thus, by Dana, in discussing the material brought down by the Connecticut River during the Champlain epoch. Again, the ore-dresser has crushed rock, which he wishes to sort by means of a current decreasing in velocity in its course. The question is, Where will the particles of different sizes drop? I do not know any other cases of practical application. Certainly it can have no application to matters in solution.

JOSEPH LE CONTE.

BERKELEY, CAL., *November* 22, 1883.

EDITOR'S TABLE.

SCIENCE AS A HOPE IN POLITICS.

THE following paragraph has been circulating through the newspapers: "The Lord Mayor of London, in welcoming Professor Huxley to the city recently, suggested that the position of President of the Royal Society was really one of even greater importance than that of Prime Minister; Mr. Gladstone is chief Minister of England, but Professor Huxley was 'the head of the intellectual life of the world.'" The complaisant utterances of eminent officials, who are ever expected to say the agreeable thing that shall put their guests at ease, are not to be taken too seriously; yet there is considerable significance in this declaration of the Lord Mayor of London, both from its implication of the vast changes that have been wrought by science in the views of human affairs, and from the open recognition of these changes by so conspicuous a party.

The advance of science is evinced in numberless ways, but our weightiest proof of it is found in the gradual acceptance of enlarged in place of narrower views of the subject. New discoveries are important; the widening of the ranges of research is important; the extension of generalizations and the better organization of positive knowledge are important; but more important still is the growing general recognition that science is the grand agency in modern times for reshaping the common opinions of the community.

By the narrower view of science, we mean what may be called that professional conception of it by which it is restricted to certain definite experimental results. Our literary and theological friends are especially solicitous that the term science should be confined to *physical* science merely—laboratory science, observatory science, manipulatory science of any sort that can be regarded as belonging properly to specialists. But they grow jealous of it when it takes on that wider and deeper meaning which has been given to it by the growth of ideas in these later times, and when it is seen to involve a new method of thought, of the most comprehensive application, and bearing upon the whole circle of human interests. They are very commendatory of science, so long as it is busy establishing new physical facts and extending new physical truths, but they regard it as an impertinent usurper when it interferes with that old order of conceptions which pervades the common life.

But it has long been seen by the more discerning that one of the great

results of the striking advance and widening influence of modern scientific knowledge must be a sharp revision of the ancient and current valuations of great men. The old standards can not continue to be accepted, and the declaration of the Lord Mayor of London is a clear admission of it. He represents the position of Professor Huxley as President of the Royal Society not merely as the head of an eminent body of English investigators, distinguished as that position would be, but as "the head of the intellectual life of the world," and he gives greater emphasis to the statement by affirming that Huxley's position is "really one of even greater importance" than that of Gladstone, Prime Minister of England. This is in no sense a comparison of the talents or genius of two distinguished personalities, but a comparison of their positions as representative men, and an affirmation of the superiority of the illustrious scientist to the illustrious politician. The deeper meaning of this averment is that it brings into contrast two types of character—that formed under scientific influences and embodying its spirit, and that formed under political influences and embodying its spirit. The immense import of the statement arises from its recognition that a new order of men has arisen in these times and worked its way to acknowledged supereminence as leaders in "the intellectual life of the world." This means a great deal.

Undoubtedly the great changes of modern thought which threaten to displace an old ideal of great men, and to substitute a new ideal, have far-reaching consequences, which may turn out to be of the most practical kind. It would be folly to deny that in recent years there has been a rapid decline in the respect generally entertained for eminent political men. The world has always worshiped successful politicians, and will no doubt long continue to worship them as the embodiments of power in society; but, as the possession of political power becomes more and more a matter of accident, there will be increasing hollowness in the homage rendered to those who have had the good luck to get possession of official places. Already political success has altogether ceased to imply greatness of character; the machinery of partisan politics may give prominence to a wary and skillful manager—the tricky manœuvring of a convention may furnish a President—but nobody is deceived into supposing that distinguished merit is thereby disclosed, or that genuine greatness has met with the honor to which it is entitled. Incontestably, there are no such shams and humbugs in modern society as successful politicians. We do not expect them to be men of solid acquisitions, to have mastered the knowledge that is needful for statesmen, or to exemplify anything like manliness and independence of character. These traits are all in the way of political success. Transparency and uprightness of mind are not wanted, insincerity and crookedness of mind are indispensable to the political manager. He views all things with reference to immediate results, and holds any expedients justifiable that will enable him to win in partisan conflict. The school of politics, in short, gives us men that are not entitled to public respect, and this scandalous fact is universally understood.

But are we to regard this as the hopeless finality of things in the political and public sphere? There are strong reasons for taking a different view and indulging in better anticipations. Agencies are at work which will form men of more elevated character. We look to the extension of science and the deepening of scientific influences to give us minds capable of improving the existing state of things. It is impossible to overestimate the good that may be hoped from this scientific influence, as it becomes strengthened and organized and brought to bear

upon public affairs, because science is allegiance to truth, while current politics is little else than allegiance to lies. No man expects that a politician will be honest, or candid, or truthful, or make a bold and honorable avowal of principles; nor is there any possible ground to hope that our politics will purify themselves by any working of their internal elements so that men of probity, high character, and real greatness will be put in the positions of power. The regenerative influence, if it comes at all, must come from other sources, and we expect it to come sooner or later from the great movement of modern science, which must bring with it a new training in the intellectual virtues. It is to the new conceptions and new culture of science that we look for the production of men of a higher quality for public use to replace that lower quality which has ceased to command the admiration of intelligent and honorable-minded people. Our politics is to-day the despair of our most earnest citizens, and we can see no possible escape from its corruption and its degradation but by the supply of new men animated by higher ideas, qualified by superior intelligence, and trained in reverence for truth, and these men are to be produced by the slowly ripening influence of science, as it comes gradually to pervade our educational systems. Of course, no great change of this kind can be suddenly precipitated; it must be a slow growth, to work effectual results; but science advances with its work, and gives us some ground of hope even in the most discouraging of all the fields of human effort.

EDUCATION WITHOUT DEAD LANGUAGES.

One would think that the advocates of the classics, as the one superior system for the unfolding of the human mind, would have long ago abated their exclusive pretensions in face of the fact that such multitudes fail with it, and that so many succeed without it. It is not found difficult to evade the force of the first objection that great numbers of dead-language students come to nothing with their classics, because it is said that they neglect their opportunities, or get far more good from this source than they are ever aware of. But it is not so easy to escape the objection to the wonderful worth of defunct speech in the cultivation of the human faculties with such multiplying evidence as we have of great intellectual power acquired by a mental cultivation into which the dead languages have never entered. That these studies have declined in consideration, and are put upon the defensive, and fall back upon tradition and authority for backing, is simply because other instruments of culture in these modern times are not only competing with them but are beating them everywhere. Accompanying the decline of the classics, there has arisen an outside education, irregular in form, unguided by institutions, self-inspired and self-shaped, which is full of great results. The past generation has abounded in men who have either turned their backs upon the universities, after trying them, or who have never gone near them, but who have become leaders of thought in all departments of intellectual activity. The unfortunate creatures who have been enticed to college, and there loaded down with a knapsack of dead languages have found, as was very natural, that they were overweighted in the competitive race of practical life, and left behind by those whose acquisitions are better adapted to the new requirements of the age. Charles Darwin went to the university, neglected the classics, and made what he could out of it for the promotion of his natural history studies; and Herbert Spencer refused to be lured there at all. Yet these are the men who are guiding the mind of the age, while for twenty years we have been afflicted with the

pitiful protestations of classical graduates (with their incomparable "mental discipline") that they could not even understand the epoch-making books of these great thinkers.

From this point of view, the English experience with classical studies is especially rich in instruction. Every public influence in that old, aristocratic, tradition-ridden country has favored the ascendency and the perpetuity of dead languages in all grades of education. Whatever benefits could be got from them have been there obtained in abounding measure. Modern knowledge has been hindered and repressed that the classics might have free course and undisputed sway; and yet, as we have before observed, the system worked out such miserable and scandalous results that the state was compelled to look into the subject and do what it could to expose if not to correct the abuses. The Government reports on the condition of education in the universities and great public schools revealed a state of things which will be the wonder of all future ages. Some twenty years ago, Prof. W. P. Atkinson, of Boston, printed a very valuable pamphlet devoted to these English educational reports. We regret to say that it is now out of print, for it would be an invaluable contribution to the discussion now going forward upon this question. As its contents will be new to many, we reprint some passages illustrating the extent to which, even at that time, the classical university education had been practically superseded by forms of culture more suited to the necessities of the times:

> This view [that the English universities have lost the hold they once had on the educated classes] will be corroborated if we consider how many of the most influential minds of the century, in science, literature, art, and politics, have either had no connection whatever with the universities, or are under small obligation to them for any connection they may have had. In politics, and political economy, we might name, among others, Romilly, Bentham, Ricardo, Bright, Cobden, Stuart Mill. Though the government of England is monopolized by the aristocracy, the political thought which governs her governors comes daily more and more from the people. The list of "uneducated" men of science—if I may be allowed the absurdity of such a phrase—is far longer, as, after what has been said, might reasonably be expected, than any the universities can show—Davy, Wollaston, Dalton, Faraday, Wheatstone, De la Beche, Murchison, Hind, South, Fitzroy, Playfair, Carpenter—it might be indefinitely extended; and we shall find that the most eminent of her college-educated men of science are the foremost in denouncing her university system. Of course, all her great engineers, inventors, and builders, are uneducated men—Watt, Telford, Smeaton, Rennie, Brindley, the Brunels, the Stephensons, Sir Joseph Paxton—it is with these names that that sad but glorious volume, "The Pursuit of Knowledge under Difficulties," is filled. Her great artists are all "uneducated" men—Flaxman and Gibson, Landseer, Turner, and Stanfield, Kemble and Macready, and all the rest. And, when we turn to literature itself, the greatest English historical work of this generation—a work on classic history, too—was written by an "uneducated" London banker. The greatest, I might almost say the only, English attempt at a philosophy of history, a work which, with all its errors and paradoxes—and I shall not deny that they are many and great—is still one which can not be matched by any similar academic performance, was the work of the "uneducated" son of a London merchant. Her novelists—Dickens, Thackeray, Jerrold, Marryat—come from all quarters save the banks of the Cam and the Isis; not to mention so many of that sex which is excluded altogether from their sacred borders. Bulwer is, indeed, a Cambridge man, but I think Cambridge will be slow to put forward that pretentious charlatan as an example of the fruits of her classical training. Even of her poets, critics, and essayists, what a long list are among the wholly "uneducated," or must be classed among those who derived no benefit from their stay at a university, save that (undoubtedly great) one which comes from mere residence at a place of learning! The names at once occur of Crabbe, Rogers, Lamb, Moore, Montgomery, Hunt, Gifford, Hazlitt, Hood. Who would hesitate to say where Scott's real education lay? Who has criticised the education of Oxford so wittily as Sydney Smith, or so grimly as Carlyle? Wordsworth and Coleridge, in their short

stay at the university, owed little or nothing to the studies of the place. Southey says he only learned to *swim* there—badly; Byron was ruined there; and the beautiful genius of Shelley found there, instead of the help and guidance it so much needed, only cruel and ignominious abuse. Keats, some of whose exquisite poems breathe the very spirit of classical antiquity, was a stable-keeper's son, and never studied at public school or university. England's eminent surgeons and physicians are not university men; and what is it that in that country keeps theology so far behind all other sciences, but the fact that the clergy are the only profession who are *compelled* to subject their minds to the full "dementalizing" power of Oxford training? What power less potent could produce the bigotry of an English High-Church bishop? I am not forgetful of the eminent names that may be produced on the other side; but, even in regard to these, the question must always be asked, How far was their eminence due to their education? The real relation in which the English schools and universities stand to her greatest minds, even in the past, and the share which university teaching really had in training them, is a problem that still needs elucidation. "We are not sure," says the present Lord Brougham, writing in 1826, "whether the result of the investigation would be so favorable as is commonly supposed to Oxford and Cambridge. And of this we are sure, that many persons, who, since they have risen to eminence, are perpetually cited as proofs of the beneficial tendency of English education, were at college never mentioned but as idle, frivolous men, fond of desultory reading, and negligent of the studies of the place. It would be indelicate to name the living; but we may venture to speak more particularly of the dead. It is truly curious to observe the use that is made, in such discussions, of names which we acknowledge to be glorious, but in which the colleges have no reason to glory—that of Bacon, who reprobated their fundamental constitution; of Dryden, who abjured his Alma Mater, and regretted that he had passed his youth under her care; of Locke, who was censured and expelled; of Milton, whose person was outraged at one university, and whose works were committed to the flames at the other.

It may, perhaps, be argued that many of the "uneducated" men whom I have been enumerating would have been the better for a university training. For a *true* university training, no doubt they would—one that would have developed all their powers harmoniously, while it gave full play to their special genius. With the advocates of such a training, I have here no controversy; I will even grant that many of these writers, in spite of their genius, betray the faults which are wont to mark the self-educated man. But would it have been better for Mr. Buckle himself if, by a long course of nonsense-verses, the attempt had been made to flatter and polish him down to the regulation standard of Oxford mediocrity? Mr. Buckle at least stimulates us to think; can as much be said of Oxford bishops? There is a passage in a recently published book of travels in Russia, by Professor Piazzi Smyth, the Astronomer-Royal for Scotland, which bears on this question and records a somewhat surprising conclusion. Describing a conversation he had with that eminent astronomer, Struve, as to the results of their experience in university teaching, both agreed that on many points further inquiry was greatly needed; but Professor Struve said that "this conclusion had been drawn independently by so many differently circumstanced men in the Russian and German-Baltic provinces, from the general impressions which their recollections gave them, that there could be little doubt of its containing much truth—truth, too, of a startling character: *the first boys at school disappear at the colleges, and those who are first in the colleges disappear in the world.*" I am not sure that a similar conclusion would not follow from a similar investigation into our own, as well as into English and German academical history, and that it would not be found that the men most useful and successful in after-life were not those who had placed themselves most fully under the influence of college training, or been stimulated to exertion by mere hope of college rewards, but those who had been most successful in *escaping* its narrowing influences, while, on the other hand, they had also escaped the still greater dangers of idleness and dissipation in the formative period of their history—men who had cast from them the trammels of pedantry, and with independent energy marked out their own career.

We publish the first of a series of articles on some of the political tendencies of the times, by Herbert Spencer. The present paper, though treating of affairs in England, and therefore full of English illustrations, will be found to have a bearing upon urgent questions in this country, and to in-

volve, indeed, some of the most radical problems of popular government. We have been told that the price of liberty is eternal vigilance, and the truth is far more pregnant than is generally supposed. But we require to learn a still more elementary lesson, that is, what liberty is. Our common notion of slavery has come to be negroes sold at auction, and our notion of liberty has come to be the privilege of locomotion and of voting. A people with such notions of the subject will hardly be very vigilant in paying the price of liberty by strenuously resisting all encroachments upon individual rights. Therefore, every discussion which makes the subject clearer, and calls attention to considerations which are apt to be generally overlooked and forgotten, is important; and nowhere is it more important to guard against the indifference of citizens and the fallacies by which they are misled on the subject of liberty than where government is popularly administered. Mr. Spencer's future papers will probably bear much more directly upon American political problems than the present.

LITERARY NOTICES.

WORLD-LIFE; OR, COMPARATIVE GEOLOGY. By ALEXANDER WINCHELL, LL. D., Professor of Geology and Paleontology in the University of Michigan. Chicago: S. C. Griggs & Co. Pp. 642. Price, $2.50.

IN this compact but comprehensive book Professor Winchell has made a contribution to science that was greatly needed, and he has performed his task in a manner that well comports with the grandeur of the subject. A carefully prepared book, representing the present state of knowledge on "the processes of world-formation, world-growth, and world-decadence," has been urgently needed for some years. There is, no doubt, much shallow skepticism in many minds regarding the validity of inquiries in this field, which has been relegated to the sphere of scientific romance and fanciful speculation. But sober and well-instructed minds have not shared in this feeling. Our knowledge concerning the genesis of worlds is, of course, yet very incomplete, and there is necessarily much of that divergence of opinion in relation to it which always belongs to the stage of active advancing inquiry. But there is already a great body of assured and formulated knowledge bearing upon the problem of the genesis of worlds which is not to be gainsaid, and there has been the steadily increasing necessity that this knowledge should be collated, and organized into definite scientific form. But a somewhat special preparation was required to do anything like tolerable justice to this work. The factors of the discussion are of the largest import. Celestial mechanics has long been the fundamental element of the research, and within recent years celestial chemistry has come forward as of equal importance. Nebular cosmogony and nebular evolution are now established conceptions of science, and, in working them out, the sciences of geology and astronomy are of equal significance and application. Professor Winchell refers to his task as an attempt at "laying the foundations of a science which, from one point of view, may be styled the geology of the stars, and, from another, the astronomy of the earth. It is the science of comparative geology. It is astrogeology." In regard to the present position of the nebular view, the author remarks: "Nor can it be correctly said that the general theory remains still in the status of an hypothesis. In certain points of detail opinion may still remain divided; but, when an hypothesis has stood the scrutiny of three generations, and has become all but unanimously accepted, by those prepared to form original opinions, as the real expression of a method in nature, surely, then, the time has passed when any person can advantageously illustrate his learning and sagacity by continuing to reproach the conception as 'a mere hypothesis.' If any 'mere hypothesis' ever strengthened into the condition of a scientific doctrine, assuredly we find in the scientific world today the general features of a sound nebular doctrine."

Professor Winchell's geological studies, long carried on in connection with the cosmical problems which they involve, have well

prepared him for the broad investigation which has led to the writing of the present volume; but the problems of the nebular hypothesis have long occupied a large amount of attention with him, and been made a subject of his college lectures, so that he has made it a point to master the various special questions that have recently come forward in connection with this subject. We know of no other work in which the reader can find a full, connected, and systematic presentation of the results of cosmical research that will compare with this, and we are especially glad to see that the publishers have put it at a reasonable and popular price.

No sufficient account of the contents of the book can be offered in the space at our command, but we give an imperfect outline of the main features of the exposition.

The book is divided into four parts, of which Part I, entitled "World-Stuff," treats of the process by which the constituent particles of worlds become aggregated into spheroidal masses. The meteoric matter which is constantly falling upon the earth in masses varying from dust-particles to meteorites of several tons weight, the zodiacal light, which polariscopic study shows to be reflected sunlight, comets, which are now known to be simply conglomerations of cosmical dust, the rings of Saturn, and the irresolvable nebulæ, all go to show that a vast amount of matter such as our earth is made of, must exist diffused in space. "All the moving bodies of our system must be continually pelted by these cosmical atoms, and the aggregate result of these collisions must, in thousands or millions of years, affect their motions. Supposing the motions of the cosmical atoms to have no prevailing direction, it is evident that the motions of the planets, satellites, and comets of our system would cause them to meet more of these atoms than the total number which would overtake them. The result would, therefore, be a resistance to the movement of these bodies, and the effect of this would be an acceleration of their motions and a shortening of their periods. I venture the opinion that this cause is a more efficient resistance than the supposed ethereal medium." These material particles are drawn by mutual attraction into groups, and any central attractive force, as of a sun or planet, would also cause them to aggregate, by deflecting their motions into converging lines. But, in the presence of two or more attractive centers, as in the present constitution of the cosmos, it is impossible that any mass shall fall directly upon its center of attraction; hence every body would tend to circulate about every other body. But the resulting movements would be so infinitely complex as to precipitate countless collisions of particles and masses. Each group or swarm which gradually forms will have a progressive motion along a path having the essential character of an orbit around some dominant center of attraction. If any condition of interplanetary matter exists in space, its resistance would cause the smaller particles to fall behind, and the whole swarm to assume an elongated fan-shape. The attractions that control these motions would be feeble; sometimes the controlling one would be only that of another cosmical swarm. Most of these swarms of cosmical dust would simply float poised in space, growing by accession of particles, and occasionally coalescing with other clouds, until an aggregation is formed large enough to be called a nebula. From these various attractions and collisions the nebula would have acquired a rotary motion. It would assume the form of an oblate spheroid, and, as the cloud-like mass cooled, the consequent contraction would increase the speed of rotation, until an equatorial ringlet of particles gained a centrifugal tendency equal to the centripetal. Further contraction would cause the main body of the spheroid to shrink away from this ring, which would then rotate independently. We might suppose that successive slender ringlets would become detached until the whole mass was converted into an essentially continuous disk, for the attraction of the ring first separated would be added to the centrifugal force of the circlet of particles nearest it, and so on. But every successive addition to the annular mass increases its distance from the next ringlet of particles, and upon this its influence, though increasing with the growth of the ring, diminishes as the square of the distance increases. As a result, "an annular mass of relatively considerable amount would separate, and a secular interval would

intervene before the separation of another annular mass." None of these rings could long remain of uniform thickness. Each would attenuate in some part, and finally rupture, resolving itself into a mass that would possess a rotary motion, the direction of which would be determined by the relation of the velocities of the outer and inner zones of the ring.

Part II, "Planetology," occupies about half the volume. In the first chapter of it, certain observed phenomena of the solar system are enumerated which accord with the requirements of the nebular theory, and objections to the theory are answered. For the retrograde motions of the satellites of Uranus and Neptune our author advances several explanations: 1. It is entirely conceivable that both the Uranian and Neptunian systems should have suffered a tilting through more than a right angle by the influence of some powerfully attracting body passing in the neighborhood. 2. The coalescence of two or more spheroids may have tilted the axis of the resultant planet, and its whole system of satellites would be correspondingly tilted. 3. Certain relations of density, distance from the center of the nebulous mass, breadth of ring, and velocity might cause retrograde motion in the earlier stages of the evolution of a nebula of a certain magnitude. The next chapter describes the passage of a gaseous planet to the molten phase, the solidification of its core from pressure of the superincumbent portions, the incrustation of its surface, and the transformations of this crust. A large influence on planetary history is ascribed to tidal action, a tide being defined as "the prolateness of a body resulting from the attraction of another body." Coming to some special considerations of the planetary bodies in the solar system, Professor Winchell mentions three independent conceivable causes for the molten condition in which a part of the earth's substance evidently is: "There may be a zone too deep for solidification by cooling, and too shallow for solidification by pressure. . . . In the next place, we may suppose that at all depths beneath the surface the pressure is such that the fusing-point is higher than the actual temperature, so that a state of solidity exists. . . . We may conceive that heat and fusion result from some mechanical crushing pressure." In regard to this last theory he says, further: "But a cause of crushing pressure which seems to me more adequate than secular cooling is suggested by Sir William Thomson's and Archdeacon Pratt's, and, we may add, Professor G. H. Darwin's, demonstrations of tidal effects in a globe as rigid as steel or glass. May not the tidal deformations of the earth's crust be the source of the internal heat which manifests itself in fluidity? The whole value of the lunar tidal oscillation in a yielding globe should be about fifty-eight inches. In a globe as rigid as glass it should, therefore, be about 34·8 inches, and, in one as rigid as steel, 19·33 inches. The whole tidal oscillation under the joint maximum influence of the sun and moon in a perfectly yielding globe would be about 81·2 inches. The amount in a globe of glass would, therefore, be, when at a maximum, 48·72 inches, and, in a globe of steel, 27·06 inches. Should the terrestrial globe yield to the extent of any one of these amounts, the crushing effect experienced by the superior zones of the crust would not be uniformly distributed, since variations in structure and hardness and surface configuration would preserve certain portions from any change, and the whole amount of the interstitial displacements would be accumulated in the remaining portions. It does not seem at all improbable that the transformation of such enormous mechanical force into heat should suffice to bring to a state of fusion volumes considerable enough to answer all the requirements of the thermal manifestations of modern times, as well as the terrestrial movements of modern earthquakes." From an examination of the planetology of the moon he concludes that "lunar history must have presented characteristics widely divergent from those of terrestrial history; and in this divergence the tenuity of the moon's atmosphere has performed a part quite comparable with the energetic work of the tides. . . .

"The question of the habitability of other worlds has generally been discussed from the assumption that all other corporeal beings must be clothed in flesh and bones similar to those of terrestrial animals, and must be adapted to a similar physical envi-

ronment. But it is manifest, on a moment's consideration, that corporeality may exist under very divergent conditions. It is not at all improbable that substances of a refractory nature might be so mixed with other substances, known or unknown to us, as to be capable of enduring vastly greater vicissitudes of heat and cold than is possible with terrestrial organisms. . . . There may be intelligences corporealized after some concept not involving the processes of ingestion, assimilation, and reproduction. Such bodies would not require daily food and warmth. They might be lost in the abysses of the ocean, or laid up on a stormy cliff through the tempests of an Arctic winter, or plunged in a volcano for a hundred years, and yet retain consciousness and thought. It is conceivable. Why might not psychic natures be enshrined in indestructible flint and platinum? These substances are no further from the nature of intelligence than carbon, hydrogen, oxygen, and lime."

"General Cosmogony" is the title of Part III, which consists of a short chapter on the condition of the fixed stars and nebulæ, with some general considerations on the whole system. "Evolution of Cosmogonic Doctrine" occupies the rest of the volume. In these concluding chapters the growth of man's view of the universe is traced from the partial conceptions of the Greek philosophers to the comprehensive system of modern astronomers. The theories of Kepler, Descartes, Leibnitz, Swedenborg, and Thomas Wright, are described briefly, and that of Kant is given with some detail. Then follow the views of Lambert, Sir William Herschel, and Laplace, and a brief "Systematic Résumé of Opinions."

MAN A CREATIVE FIRST CAUSE: TWO Discourses delivered at Concord, Mass., July, 1882. By ROWLAND G. HAZARD, LL. D. Boston: Houghton, Mifflin & Co. Pp. 112.

In this instructive little volume we have a compact and very lucid restatement of the leading philosophical views of its veteran author, which were several years ago developed in an extended form in his more elaborate works. Mr. Hazard is well known as a man of original and versatile thought, and has dealt with a considerable variety of subjects, practical as well as theoretical, in his various publications; but he will probably be best known in the future by his comprehensive metaphysical treatise entitled "On the Freedom of the Mind in Willing." The origin of this work is, on various accounts, so interesting and significant, that it should not be forgotten.

The celebrated Dr. William Ellery Channing, whose reputation is world-wide as a gifted preacher, a discriminating philanthropist, and as the father of American liberal theology, is understood to have been in a somewhat unsettled state of mind upon what may be regarded as the logic of the old free-will controversy. He is said to have "confessed to an incapacity to form any satisfactory philosophical theory and defense of that moral freedom in which he devoutly and earnestly believed." Dissatisfied with all that had been written upon the problem, and confessedly unable himself to cope with its difficulties, and at the same time holding inflexibly by the doctrine of mental liberty in volition, he was very naturally solicitous to see the question handled by some powerful intellect, qualified for the research, and who could put the proofs of man's moral liberty on a firmer basis than they had hitherto occupied. But who was to be found competent to enter upon this formidable task? Learned scholars were sufficiently abundant. The colleges turned out their annual multitude of men who had been long steeped in recondite studies; whose intellects had been disciplined and sharpened by those marvelous instrumentalities destined from the foundations of the world "for the perpetual training of the minds of the later generations," the dead languages, but Dr. Channing did not find his man in this class. In his celebrated essay on "Self-Culture," there occurs the following passage: "I have known a man of vigorous intellect who had enjoyed few advantages of early education, whose mind was almost engrossed by the details of an extensive business, who composed a book of much originality of thought in steamboats, on horseback, while visiting distant customers."

The book here referred to was entitled "Language: an Essay," and was written forty-seven years ago by Mr. Hazard. Dr.

Channing was so impressed by the work, that he sought the author out, made his acquaintance, and found that, notwithstanding his "few advantages of early education," he gave better promise of ability to grapple with a profound metaphysical problem, and make more progress in its analysis, than any of the regulation scholars with whom he was acquainted. An authoritative critic speaks as follows of Mr. Hazard's first work, the essay on language:

> The essay was not more worthy of attention from the circumstances under which it was written than from the interest and freshness, if not the absolute originality, of some of its thinking. The tone of the first essay is that of a refined and elevated idealism in its underlying philosophy and in the moral earnestness of its practical spirit. The essay was highly esteemed in those days of transcendental aspiration, and excited a very general curiosity among the eager seekers after new truths and new prophets. Unlike many of the effusions of the taught and untaught seers of those effervescing years, this essay was in every line clear, analytic, and severely reasoned. It was, however, as characteristically idealistic in its philosophical spirit as it was imaginative in its poetical and ethical portraitures. The essay put Dr. Channing upon the quest to discover its author, and this discovery led to a friendly intimacy between the two till the death of the philosophic divine, which was commemorated by an affectionate yet discriminating essay from his philosophic *protégé* and friend.

Yielding to the earnest injunction of Dr. Channing, Mr. Hazard early in life took up the question of free-will, and published the results of his studies in two solid volumes, "Freedom of the Mind in Willing, etc." (1864); and two letters on "Causation," and "Freedom in Willing," addressed to John Stuart Mill (1869). Those who desire to become familiar with Mr. Hazard's reasoning in its full elaboration must consult these works; in the volume before us the results are necessarily much epitomized.

Into the merits of the great question of free-will we can not, of course, here enter. It is alleged that modern science, by its vast extension of the idea of natural law, has strengthened the conceptions of necessity and fatalism at the expense of moral freedom. But determinism never had a more powerful champion than Jonathan Edwards, and he certainly did not draw his inspiration from modern science. Mr. Hazard takes broad issue with Edwards. Professor Huxley, a leading "automatist," and representing the latest science, admits that "volition counts for something"—but the philosophical question is, For how much? Nobody claims that the will is unlimited. The title of Mr. Hazard's book, "Man a Creative First Cause," seems rather startling at first, but it is because of our theological connotations of the term "creative." His obvious implication is of the mind willing and working in its own sphere, where we properly speak of *creative* genius and *originating* capacity. Indeed, Mr. Hazard explicitly says: "Exterior to itself, it (the human mind) may not have the power to execute what it wills; it may be frustrated by other external forces, since in the *external* the ideal incipient creation may not be consummated by finite effort. But, as in our *moral nature* the willing, the persevering effort, is itself the consummation, there can be no such failure; and the mind in it is therefore not only a creative but a supreme creative first cause.

Mr. Hazard's book is tersely and vigorously written, and takes a somewhat wide range both of philosophical and practical suggestion. The author has a sturdy faith in the value of metaphysical studies for practical utility as a mental training, and also in their disciplinary power for the formation of human character. This view is incidentally presented, and we only regret that he has not more fully and formally developed it. Such a discussion would be valuable to education, and we are not without hope that Mr. Hazard may yet find it practicable to give fuller expression to his views and reasonings upon the subject.

INTERNATIONAL SCIENTIFIC SERIES. VOL. XLVI.

THE ORGANS OF SPEECH, AND THEIR APPLICATION IN THE FORMATION OF ARTICULATE SOUNDS. By G. H. VON MEYER, Professor in the University of Zürich. New York: D. Appleton & Co. Pp. 349. Price, $1.75.

THERE has long been wanted a first-class work on this interesting subject, treated with reference to the requirements of ordinary intelligent readers. It has, of course, been familiar in a certain way to the anatomists who have dissected the vocal structures with reference to pathology and surgery, and given the representations of the parts in their text-books. But the com-

bination of physiology with anatomy, and the study of function in connection with structure, and especially the later progress in acoustical science, have given a new interest to the vocal apparatus quite beyond that of the bare anatomist. The subject of the vocal organs, considered in relation to their marvelous capacities, or the most wonderful results obtained from the simplest means, is one of quite extraordinary interest. We hear much of the subtilties, refinements, and complexities of vocal language, with its hundreds of forms among different peoples, its millions of words, its capacity of expressing numberless shades of feeling, and conveying the highest spiritual influence. But, besides the common uses of speech in conversation, reading, and oratory, we are all familiar with vocal music as an art, inexhaustible in its variety of styles, and the ranges of its development. But what is the foundation of all this? Nothing but mechanism, bellows, and mechanical arrangements for acting upon currents of air for the production and control of sound. This side of the subject, being merely mechanical and material, has had but little interest for those who care only about the effects. When people lose their voices, they are reminded that there is a mechanism involved, and consult the doctor to find out what ails their vocal organs; but there has been so little other concern about them, that any thorough-going scientific investigation of their wonderful capacities and working has been long neglected.

Dr. Meyer's work is a contribution to the physiological science of the vocal organs from this point of view. It is an original treatise, with strong philological bearings, and contains various new interpretations, the result of the author's special and extensive researches. The object and plan of the work can not be better presented than in the language of the author in his preface:

> The more we become convinced that a true knowledge of the laws which govern the transformation of the elements of speech, in the formation of dialects or derivative languages, can only be obtained from a study of the physiological laws of the formation of articulate sounds, the more necessary does it become for the philologist to be thoroughly acquainted with the structure and functions of the organs of speech. The ordinary anatomical handbooks are little adapted to this purpose, for much is there discussed at length which is of no use to the philologist; while, on the other hand, points which to him are of considerable importance are only briefly alluded to. In physiological hand-books, also, only a short space is in most cases devoted to this subject.
>
> It is, therefore, my object, in the present work, to discuss, with special reference to this requirement of the philologist, the structure and functions of the organs of speech.
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> In explaining the origin of articulate sounds, I have so far departed from the usual method that I have not attempted to arrange physiologically the entire series of sounds employed in the most differing languages; but rather, starting from the structure of the organs of speech, to give a sketch of all possible articulate sounds. I believe I have thus constructed a system in which all known articulate sounds, and all those with which we may hereafter become acquainted, will find a place. Such a sketch could not, of course, be given without reference to existing languages. The object has not been, however, to enter into the field of discussion upon the various modifications of sounds, but merely to bring forward a sufficient number of examples in confirmation of the laws explained, for which purpose the more nearly related European languages are sufficient.

OCEAN GROVE CAMP-MEETING ASSOCIATION. Fourteenth Annual Report. Ocean Grove, N. J. Published by order of the Association. Pp. 75.

THE friends of the Association were disturbed much more than they had reason to be last year by some dozen lines concerning unhealthy conditions that had been noticed at Ocean Grove, which we published in the course of an article of considerable length, dealing with the sanitary condition of seaside resorts generally. Without further noticing the unkind words—the more unkind because they are undeserved—which the president of the Association still applies to us, we call attention to the confessions contained in the present report that there were things at the Grove that needed remedying, and to the gratifying fact that the Association has applied the remedies. Owing to what the report calls continuous and studied misrepresentations, a prejudice existed, "to remove which required our most energetic toil. To meet the expenses of such labor demanded funds largely in advance of current receipts." If only a prejudice, and that false, why so much labor and expense in building sewers and sinking an artesian well to remove what was only ideal and unfounded? A system of sewerage was begun about three years ago. "The plan of running the sewage

into tanks, and letting it out periodically into the sea, had many objections, and was only partially successful. Another must be devised. . . . The result is so triumphantly satisfactory that Dr. E. M. Hunt, the Secretary of the New Jersey State Board of Health, after a very careful examination of its work, pronounced it not only satisfactory but the most complete that could be made." It embraces 15,050 feet of twelve-inch mains, and 8,500 feet of connecting lines, or in all 23,550 feet, or four and one half miles of sewer, connecting with all the large and with many of the smaller houses. Of the work of the year, the president is glad to state that "an offensive condition of things which has for several years caused much complaint, in the rear of the tents near the Trenton House, has been effectually removed, and the water-closet arrangements have been so adjusted as to give perfect satisfaction to those immediately concerned, greatly to the relief of the management of the Grove." An artesian well was opened in August, having a depth of 420 feet, and delivering about a barrel of water a minute. There are also at least 800 tube-wells which draw water from a depth of from twenty to thirty feet. Dr. Hunt says, in his report of the State Board of Health, that the sanitary prospects of the Grove have been greatly improved "the last year." The township Board of Health examined the sewer arrangements and report them satisfactory in every respect. Physicians at Ocean Grove and Asbury Park declare that the sanitary conditions of Ocean Grove were never so good; and some of them that the sanitary conditions there are superior to those of any other of the watering places of New Jersey. "The Popular Science Monthly" is as glad as the officers of the Association or its best friends can be that it has been so successful in improving the condition of things, present and prospective, and is able to make so good a showing.

THE EVOLUTIONARY SIGNIFICANCE OF HUMAN CHARACTER. By Professor E. D. COPE, Philadelphia. Pp. 12.

IN this paper Professor Cope essays a sketch of the order of development of the different faculties of the mind, and summarizes his conclusions by saying that the order of the appearance of the intelligence is nearly dependent on the development of the powers of observation. The character of most civilizations tends to diminish the power of perception, while the higher departments of reason and imagination are enlarged. The imagination reached a high development before reason had attained much strength. With the exception of a few families, the intelligence of mankind has, up to within two or three centuries, expressed itself in works of imagination. "With the modern cultivation of the natural and physical sciences, the perceptive faculties will be restored, it is to be hoped, to their true place, and thus many avenues opened up for the higher thought-power of a developed race. Thus it is that in the order of human development there is to be a return to the primitive powers of observation, without loss of the later-acquired and more noble capacities of the intellect."

HORSES: THEIR FEED AND THEIR FEET. By C. E. PAGE, M. D. New York: Fowler & Wells. Pp. 149. 75 cts.

A BOOK of plain, practical maxims on the proper keeping of horses, involving some views that are novel, but the value of which has been tested in the author's experience. A leading object is to recommend a reformed system of feeding, that we might characterize as the "two-meal" system, which is fully expounded and earnestly maintained. Accounts are given of the way Mr. Bonner and other famous fanciers treat their horses. The causes of various diseases are pointed out, and suggestions are given respecting their treatment. The question of shoeing is fully considered, and it is shown how, under many conditions, horses will do better service without shoes; and Colonel C. M. Weld contributes an account of his experience with barefoot horses.

PHOTO-MICROGRAPHS, AND HOW TO MAKE THEM. By GEORGE M. STERNBERG, M. D., United States Army. Boston: James R. Osgood & Co. Pp. 204, with Twenty Colored Heliotype Plates. $3.

THIS work, which is really an elegant, although the author modestly styles it a "little" volume, is practical, and is intended for beginners in the art to which it relates. That art, photo-micrography, is the art of taking sun-pictures of microscopic objects

more or less magnified, and is to be distinguished from micro-photography, which merely takes microscopic photographs of objects that can be seen by the naked eye. The former art is scientifically instructive, the latter merely produces curiosities. The author's object in preparing the volume has been to give such an account of the technique of the art as will enable persons familiar with the use of the microscope to make photo-micrographs of suitable objects with a minimum expenditure of time and money. The illustrations have been selected with a view of showing the kinds of microscopic objects best suited for photographing, and the results which may be expected by one who is willing to devote a little time to the mastering of technical difficulties. They represent forty-nine different objects.

SEWER-GAS AND ITS ALLEGED CAUSATION OF TYPHOID FEVER. By GEORGE HAMILTON, M. D. Pp. 12. THE STATUS OF PROFESSIONAL OPINION AND POPULAR SENTIMENT REGARDING SEWER-GAS AND CONTAMINATED WATER AS CAUSES OF TYPHOID FEVER. By GEORGE HAMILTON, M. D. Philadelphia. Pp. 10. ETIOLOGY AND NON-INFECTION OF SEWER-GASES. By WASHINGTON AYER, M. D., of San Francisco. Pp. 25.

DR. HAMILTON undertakes to controvert the sewer-gas theory of the origin of typhoid fever, by showing that the disease is not dependent upon the presence or absence of sewers, or upon any conditions of filth in large cities; and that it prevails in the country, where there are no sewers, and everything is favorable to purity of the atmosphere, more extensively and more fatally than anywhere else. Dr. Ayer maintains substantially the same points, but rather on philosophical grounds than by the citation of examples, and disputes the competency of the experiments which have been relied upon to determine that bacteria are the cause of the diseases with which they have been found associated.

THE INFLUENCE OF ATHLETIC GAMES UPON GREEK ART. By CHARLES WALDSTEIN, Esq., University of Cambridge, England. Pp. 24.

THIS paper is an inquiry into the cause of the persistency of the influence of Greek art upon us. The answer is found in the fact that Greek art is true to nature, yet not so servile as to be sensual and sensational, but is also ideal. "The ideal in art is the highest generalization of form. In Greek art it was the highest generalization of the forms of nature. The works of Greek art are, therefore, not dependent for appreciation upon one individual spectator, or one special mood of the individual, but are valid for all sane men, for all men of a certain physiological constitution of their senses, surrounded by man and nature relatively the same." The inquiry is pursued how Greek art effected this combination of the natural and the ideal. The natural was developed in the portraiture of athletes, the ideal in the effort to represent and characterize the gods.

AN INDEX TO ARTICLES RELATING TO HISTORY, BIOGRAPHY, LITERATURE, SOCIETY, AND TRAVEL, CONTAINED IN COLLECTIONS OF ESSAYS, ETC. By W. M. GRISWOLD, Bangor, Me. Q. P. Index. Pp. 56.

THIS is No. 13 of the "Q. P. Index," a series of works for the projection and execution of which Mr. Griswold, who has made it his special business, deserves the thanks of every student and reader. The character of the present number of the series is fairly well represented by its title. There are hosts of articles of great value on particular subjects inclosed in volumes of essays and miscellaneous writings, which are practically inaccessible because the general title of the volume gives no clew to what is in it. The present index gives the key to the subjects within its scope as represented in 799 volumes by different authors. The publisher hopes in time to improve upon it and enlarge it—that is, to bring other books into view.

A PHYSICIAN'S SERMON TO YOUNG MEN. By WILLIAM PRATT. New York: M. L. Holbrook & Co. Pp. 48. 25 cts.

A LECTURE to young men on the importance of personal purity and of the restraint of all tendencies to vicious indulgence, the destructive physical and moral consequences of which are pointed out in language that does not err by lack of plainness or vigor. As counteractives to vicious propensities, are recommended cold bathing, hard beds, and sleeping alone, abundant work, plain food, careful reading, right choice of companions, and religion.

HYDRAULIC TABLES FOR THE CALCULATION OF THE DISCHARGE THROUGH SEWER-PIPES AND CONDUITS. By P. J. FLYNN, C. E. New York: D. Van Nostrand. Pp. 135. 50 cts.

THE usefulness of such tables as are presented in this volume, to all persons engaged in works demanding the calculations, needs no demonstration. The tables are based on Kulter's formula.

THE OYSTER EPICURE. New York: White, Stokes & Allen. Pp. 61. 30 cts.

THIS is a collation of authorities on the gastronomy and dietetics of the oyster, the reading of which is appetizing, and calculated to make the reader wish he could find some oysters as good in the actuality as he can imagine them to be.

PUBLICATIONS RECEIVED.

Malaria as an Etiological Factor in New York City. By Simon Baruch, M. D. New York: Trow's Printing and Bookbinding Co. Pp. 22.

Continuity and Catastrophes in Geology. By the Duke of Argyll. Edinburgh: David Douglas. Pp. 32. One shilling.

A Plea for the Cure of Rupture. By Joseph H. Warren, M. D. Pp. 117, with a Plate. $1.

Proceedings of the Indiana Pharmaceutical Association, May, 1883. Indianapolis: Joseph R. Perry, Secretary. Pp. 164.

Bulletin of the United States Geological Survey, No. 1. Two Special Papers. By Whitman Cross and S. F. Emmons. Washington: Government Printing-Office. Pp. 42.

Pilot Chart of the North Atlantic, for December, with "Supplement," giving details of storms and nautical information. Washington: U. S. Hydrographic Office. (Supplement) pp. 11.

Reports of Observations and Experiments in the Division of Entomology, Department of Agriculture. Washington: Government Printing-Office. Pp. 73, with Three Plates.

Transactions of the American Dermatological Association, August, 1883. Dr. Arthur Van Harlingen, Secretary. Philadelphia. Pp. 49.

Scientific Papers of the Vassar Brothers Institute, Poughkeepsie, N. Y., 1881-'83. Leroy C. Cooley, Ph. D., Chairman. Pp. 118.

Cuentos de Hoy y Mañana. Cuadros Politicos y Sociales. (Stories of To-day and To-morrow; Political and Social Sketches.) By Rafael de C. Palomino, Jr. No. 1. New York: N. Ponce de Leon. Pp. 53.

Recherches sur le Structure de quelques Diatomées contenues dans le Cementstein du Jutland. (Researches on the Structure of Certain Diatoms contained in the Cement-Stone of Jutland.) By MM. W. Prinz and E. Van Ermengen. Brussels: A. Manceaux. Pp. 74, with Four Plates.

One Thousand and One Riddles. By Nellie Greenway. New York: J. S. Ogilvie & Co. Pp. 124. 15 cents.

Cassell's "Family Magazine," January, 1884. New York: Cassell & Co. (Limited). Pp. 64. 15 cents monthly. $1.50 a year.

Developments in the Kinetic Theory of Solids, Liquids, and Gases. By H. T. Eddy, Ph. D. Cincinnati. Pp. 16.

Local Government and Free Schools in South Carolina. By B. James Ramage, A. B. Baltimore: Johns Hopkins University. New York: G. P. Putnam's Sons. Pp. 40. 40 cents.

Suggestions on Library Architecture, American and Foreign. By J. L. Smithmeyer. Washington: Gibson Brothers. Pp. 31.

Notes on the Literature of Explosives. By Professor Charles E. Munroe, U. S. N. A., Annapolis, Md. Pp. 20.

The Evidence for Evolution in the History of the Extinct Mammalia. By E. D. Cope, Philadelphia. Salem, Mass.: Salem Press. Pp. 19.

The Winter Resorts of Florida, South Georgia, Louisiana, Texas, California, Mexico, and Cuba, and how to reach them. By John Temple Graves. Published by the Passenger Department, Savannah, Florida, and Western Railway Company. Pp. 103.

Injurious and other Insects of the State of New York. First Annual Report. By J. A. Lintner. Albany: Weed, Parsons & Co. Pp. 383.

Geology of the Comstock Lode. By George F. Becker, San Francisco, Cal. Pp. 8.

Proportional Representation: What it is and what it will do. By Simeon Stetson, San Francisco. Pp. 8.

Edison Electric Light Company. Twenty-first Bulletin. Pp. 62.

The "Medico-Legal Journal," December, 1883. New York. Pp. 96. $3 a year.

Geology of the Eureka District, Nevada. Abstract of Report. By Arnold Hague. Washington: Government Printing-Office. Pp. 50.

United States Geological Survey. Second Annual Report, 1880-'81. J. W. Powell, Director. Washington: Government Printing-Office. Pp. 558, with Sixty-two Plates.

United States Geological Survey. Third Annual Report. By J. W. Powell, Director. Washington: Government Printing-Office. Pp. 561, with Thirty-two Plates.

On the Contents of a Bone-Cave in the Island of Anguilla, West Indies. Washington: Smithsonian Institution. Pp. 80, with Five Plates.

Archivos do Museu Nacional do Rio de Janeiro. (Archives of the National Museum of Rio de Janeiro.) Vol. III, 1878. Pp. 164, with Twelve Plates. Vol. IV, 1879. Pp. 154, with Seven Plates. Vol. V, 1880. Pp. 470. Rio de Janeiro: De Machado & Co.

Where did Life begin? By G. Hilton Scribner. New York: Charles Scribner's Sons. Pp. 64.

The Güegüence: A Comedy Ballet in the Nahuatl-Spanish Dialect of Nicaragua. Edited by Daniel G. Brinton, M. D., Philadelphia. Pp. 94. $2.50.

Aboriginal American Authors and their Productions. By Daniel G. Brinton, M. D., Philadelphia. Pp. 63. $1.

Lectures on Painting. By Edward Armitage, R. A. New York: G. P. Putnam's Sons. Pp. 337.

Excursions of an Evolutionist. By John Fiske. Boston: Houghton, Mifflin & Co. Pp. 379. $2.

Martin Luther the Reformer. By Julius Koestlin. New York: Cassell & Co. (Limited). Pp. 145. 50 cents.

Health in the Household; or, Hygienic Cookery. By Susannah W. Dodds, M. D. New York: Fowler & Wells. Pp. 602. $2.

Voice, Song, and Speech. By Lennox Browne and Emil Behnke. New York: G. P. Putnam's Sons. Pp. 322.

A Guide to the Microscopical Examination of Drinking-Water. By J. D. MacDonald, F. R. S. Philadelphia: P. Blakiston, Son & Co. Pp. 83, with Twenty-five Plates. $2.75.

An Examination of the Philosophy of the Unknowable as expounded by Herbert Spencer. By William M. Lacy. Philadelphia: Benjamin F. Lacy. Pp. 235.

Electrical Directory and Advertiser: British, American, and Continental. By J. A. Berly. New York: George Cumming. Pp. 664. $2.50.

Tertiary History of the Grand Cañon District. By Clarence E. Dutton. Washington: Government Printing-Office. Pp. 264, with an Atlas containing Twenty large Plates and Panoramas.

POPULAR MISCELLANY.

The Ice Age.—At a meeting of the Academy of Natural Sciences of Philadelphia, Professor Heilprin advanced the opinion that the enormous sheet of ice which extended over a large portion of North America and Europe during the Glacial period could not have originated from a polar "ice-cap." He deemed it doubtful that there could have accumulated in the Arctic regions sufficient snow and ice to propel a glacier probably several thousand feet thick over hundreds of miles, and up slopes to heights of five or six thousand feet. Precipitation in polar regions takes place mainly in a low atmospheric zone; hence it would be impossible for so great a mass of snow to accumulate at so great an elevation as would be necessary to propel southward a glacier of the extent required by geologists. Professor Lewis called attention to a point observed some time ago by Dr. Hayes, but not yet sufficiently appreciated, namely, that the rate of increase in the thickness of the glacier diminished northward. Recent observations of his own showed the glacier to have been 800 feet thick five miles from its southern limit, and 2,000 feet thick at a point eight miles from its edge, while it was only about 3,100 feet in thickness at a distance of 100 miles, and 5,000 feet at 300 miles from its termination. Rejecting several hypotheses, Professor Lewis suggested that the ice-cap flowed south simply because it flowed toward a source of heat. Such a motion not being caused by gravity, would take place in a nearly flat field of ice, and upon his supposition the ice need not have been more than a few times its present thickness in Greenland. Professor Heilprin replied that no laws of glacial action were known which would account for the indiscriminate progression of an ice-sheet toward a source of heat, and that the molecular expansion theory, as applied to the Alpine glaciers, took no cognizance of the direction of the heat-power, but merely of that of least resistance (the trend of the slope). At a subsequent meeting he supported his views previously communicated by statistics of precipitation at different elevations on the Alps, and presented some curious calculations in regard to the rate of progression of the great ice-sheet. Allowing for it the average rate of the Alpine glaciers, one foot a day, it would have required a period of no less than 25,000 years to move from the sixty-fifth parallel of latitude to the line of its terminal moraine. But it may well be questioned if the conditions allowed progression at more than one fifth of this rate. Professor Lewis remarked that arguments, drawn from meteorological conditions as they now exist, will not in all cases apply in considering the Glacial epoch. He further suggested a probable analogy between the Antarctic ice-cap, some 25,000 miles in diameter, and the polar ice-cap of glacial times, and mentioned Croll's estimate that the former is twelve miles thick at its center. In speaking of a polar ice-cap, he did not mean to imply, however, that the ice was necessarily thickest on the pole, but that in Greenland, Labrador, the Hudson Bay region, or elsewhere, there may have been centers from which glaciers grew finally to coalesce into one mass of ice, the top strata of which flowed southward to the great terminal moraine.

Effect of Watering Plants with Acids.—Mr. L. P. Gratacap, of New York city, has published a report of experiments he has made to determine the effect of watering with solutions of acids upon plants. He experimented upon the silver-leaved geranium with hydrochloric, nitric, carbolic, formic, salicylic, sulphuric, tartaric, and citric acids, and water. The plants watered with the first six acids except salicylic were unfavorably affected from the first day of the experiment. From June 22d to September 6th none of the plants died except the carbolic-acid plant, although the nitric-acid plant succumbed shortly after the experiment terminated. Of the rest the sulphuric-acid plant was most thriving, then the hydrochloric-acid plant, and last, and just alive, the plant treated with formic acid. Analyses of the ashes of the plants showed that the acid waters tended to introduce in-

organic ingredients into their tissues. Of hyacinth-bulbs treated in a similar way, only the one treated with tannic acid developed roots. The hydrochloric-acid bulb died, and the sulphuric-acid bulb a month later. After the tannic-acid one, a bulb treated with oxalic acid did best. Tannic acid seemed to increase the intensity of the color of the flower. The plants were dwarfed by the treatment.

Temperature of the Glacial Period.—Mr. G. F. Becker closes a carefully considered review, in the "American Journal of Science," of the phenomena of glaciation with the conclusion that, if the generally received view (the substantiation of which would not be superfluous) that the sun is a gradually cooling body is correct, "it appears nearly certain that the absolute maximum in the development of glaciers is past, and that the glacial period was not one of general cold, but one of higher mean temperature at sea-level than the present." This is advanced without denying that a variety of other causes than those immediately considered by him may have had an influence, and, perhaps, a great influence, upon glaciation. "Indeed, it seems more probable that the formation of glaciers was affected by all contemporaneous changes, such as extraordinary upheavals and subsidences or periodic fluctuations in the eccentricity of the earth's orbit; but, if the reasoning offered is correct, it is not necessary to resort to such events to account for the occurrence of a glacial epoch." He believes that the production of glaciers is chiefly a question of differences between the temperatures at the sea-level and at the level at which the glacier is formed.

Pathology of the Pear.—At a meeting of the New Jersey State Microscopical Society, a paper was read by the secretary, Dr. Samuel Lockwood, on "Fecal Sclerogen," the last word meaning the indurated particles of lignine in the pear. He showed a quantity of material like sand, which had been passed by a person to whom it had caused great distress. In the microscope it looked unlike any mineral sand, and each particle was composed of a cluster of sharp-pointed crystals, like dog-toothed spar. It even resisted the action of nitric acid, but was dissolved readily by ammoniuret of copper. Suspecting its nature, he took the rind and core of a ripe Bartlett, and gave them to his bees, which were suffering from a dearth of flowers. The insects cleaned away the glucose and all the juices, leaving the pear-grit clean; which, by comparison in the microscope, was identical with the fecal grit. The truth was, the person had been feasting inordinately on ripe Bartletts. The doctor remarked that it had never been cleared up why the pear should cause to many such suffering in the alimentary canal, as its juices were really far less acrid than those of the apple. He showed that it was due to the sclerogen, or pear-grit. Each particle literally bristles with sharp angular points, and the cathartic energy is due to the mechanical action irritating the walls of the alimentary canal.

Growth of Boys and Girls.—The investigations of the Anthropometric Committee of the British Association have made more or less clear several interesting facts respecting the rate of growth of the two sexes in the British Isles. The period of most rapid growth is from birth to five years of age, and then both sexes grow alike, the girls being a little shorter and lighter than the boys. From five to ten the boys grow a little faster than the girls, but from ten to fifteen the girls grow the faster, and at between eleven and a half and fourteen and a half years old are actually taller, and from twelve and a half to fifteen and a half are heavier than the boys. The boys, however, take the lead between fifteen and twenty years, and grow at first rapidly, but afterward slower, and complete their growth at about twenty-three years, while girls grow very slowly after fifteen years of age, and attain their full stature at about the twentieth year. The tracings and tables show a slow but steady increase in stature up to the fiftieth year, and a more rapid increase in weight up to the sixtieth year in men, but the statistics of women are too few after the age of twenty-three to determine the stature and weight of their sex at the more advanced periods of life. The curve of the chest-girth in men shows an increase at a rate similar to that of the

weight up to the age of fifty years, but it appears to have no definite relation to the curve of stature. The strength of males increases rapidly from twelve to nineteen years, and at a rate similar to that of the weight; more slowly and regularly up to thirty years, after which it declines at an increasing rate to the age of sixty years. The strength of females increases at a more uniform rate from nine to nineteen years, and more slowly to thirty, after which it falls off in a manner similar to that of males. The curves of strength for the two sexes are not parallel: at eleven years females are weaker than males by twenty-two pounds, at twenty years of age by thirty-six pounds. The fact that man continues to grow in stature up to his fiftieth year contradicts the popular notions on the subject, according to which he ceases to grow before he reaches half that age.

The Extinct Volcanoes of the Pacific Slope.—According to the "Notes" furnished by Messrs. A. Hague and J. P. Iddings, of the United States Geological Survey, to the "American Journal of Science," the series of extinct volcanoes on our Pacific coast extends northward from Lassen's Peak, near the fortieth parallel, at intervals, for nearly five hundred miles, and follows in general the axial lines of the Sierra and Cascade Ranges. The more prominent peaks of the chain are Lassen's Peak and Mount Shasta, in California; Mount Pitt, Three Sisters, Mount Jefferson, and Mount Hood, in Oregon; and Mounts St. Helen's, Adams, Rainier, and Baker, in Washington Territory. Mount Rainier is the grandest one of the number, and forms the most prominent topographical object in Washington Territory. The surface features of the western part of the Territory have been greatly modified by the lava-flows of the volcano, and four of the important rivers of the region rise among its glaciers. Snow and ice cover its top, reaching downward for five or six thousand feet, while with the most marked contrast the broad base of the mountain supports a dark, dense, grand forest vegetation. The summit is formed by three peaks, the chief of which, a circular cone, with a crater about a quarter of a mile in diameter, rises to 14,444 feet above the sea. Mount Hood is situated directly on the crest of the Cascade Range, about twenty-five miles south of the Columbia River, and is 11,225 feet high. Its summit is a single peak—a portion of a rim of an ancient crater. The crater is about half a mile wide from east to west, and its encircling wall, for three fifths of the circumference, rises 450 feet above the snow and ice that fill the basin. Mount Adams and Mount St. Helen's, on the north side of the Columbia River, form, with Mount Hood, a triangle, the area of which has been the center of great volcanic activity. None of the volcanoes along the belt occupy so comparatively isolated a position as Mount Shasta, which stands upon an open plain with the neighboring hills and ridges many thousand feet lower. Its altitude is given as 14,440 feet, and, as the neighboring ridges rarely attain an altitude of over 3,000 feet, the volcano presents an imposing spectacle surpassed by few mountains in the world. As seen from the west, it presents a double cone, the smaller built upon the flanks of the larger one, and about 2,000 feet lower. Around the broad base of the mountain numerous lesser cones have broken out, one of which, Little Shasta, rises to more than 3,000 feet above the neighboring valley. Seventy miles southeast of Mount Shasta, near the boundary between Nevada and California, is Lassen's Peak, which, though it is about 10,500 feet high, is by no means so conspicuous an object as many of the volcanoes, because it is surrounded by other peaks of considerable elevation. It is a broad, irregularly shaped mountain, with four prominent summits, and bears on its slopes abundant evidence of comparatively recent extrusions of lava.

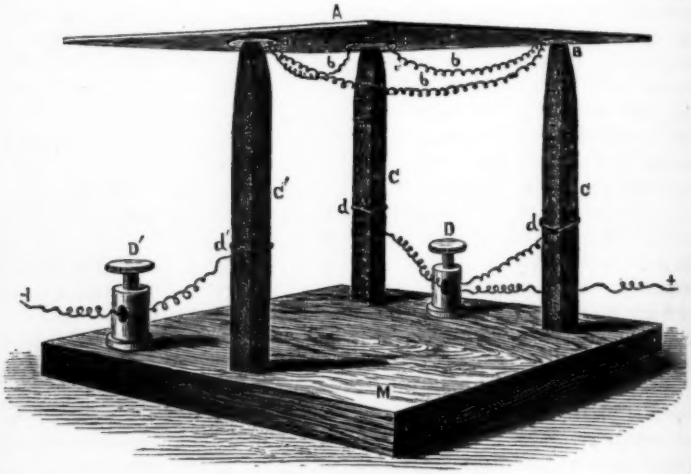
Science and Jack-Puddings.—Mr. R. A. Proctor, in "Knowledge," notices the single abusive utterance that was made against Mr. Herbert Spencer while he was in this country, and which came, not from a corner saloon, but from a pulpit, and remarks of it that it is difficult to say whether the terms used by the preacher "are more strikingly contrasted with the teaching and method of the writer he attacks or with those of the intelligent, well-trained, and well-educated clergymen who have, indeed, dissented from

some of the inferences which appear to them to follow from modern scientific theories, but who know well that they would but degrade their cause and themselves (to say nothing of their calling) were they to substitute reviling for rhetoric and railing for reasoning." Then Mr. Proctor quotes such passages from the attack as are fit for publication, and adds: "Nearly three centuries ago there was at least earnestness in the arguments used by priests, and monks, and friars, against the fearful doctrine that the earth goes round the sun. Unwise though their conduct, and unjudging their intolerance, they believed what they taught, and in their day their belief was natural enough. It is encouraging to find that in our day the advance of science is only opposed by the untaught and the foolish; only abused by the ranter and the Jack-Pudding. When we consider how necessary are certain doctrines for the world's welfare—even though hereafter they may have to give place to higher and broader and deeper truths—it is well to see that those who do their best to discredit those doctrines are not now men whose words have any weight, are not even fanatics or bigots, but simply—clowns and charlatans."

The Recent Eclipse of the Sun.—The formal reports of the observations of the solar eclipse of the 6th of May last have not yet been published; but a few preliminary statements respecting them have appeared in the journals. The American, French, and English parties arrived safely and in good time at Caroline Island, and set up their apparatus under generally satisfactory conditions. The day of the eclipse opened rather unfavorably, but the sky cleared before the first contact. The clouds continued, however, to float around, so that the corona was partly hidden during twenty seconds of the first minute of totality, and the phenomenon was wholly obscured after the cessation of totality. As totality, however, lasted for nearly five minutes and a half, good observations of that stage were obtained. The supposed intra-Mercurial planets were sought but not found. Photography does not seem to have given the results that were expected from it; but it is said that proofs were got the combination of which will permit the reconstruction of the entire corona as it was shown at the time. Mr. Hastings, of Baltimore, made some observations on the spectra of the opposite sides of the corona, from which he has drawn the conclusion that the outer portions of it are not real, but are effects of diffraction. This conclusion, "Ciel et Terre," of Brussels, observes, would account for the differences of form which the corona exhibits to different observers, but fails to account for the predominance of coronal light toward the solar equator. M. Janssen observed anew that, besides the spectrum of bright lines, the corona gives a weak continuous spectrum showing some of the principal dark rays of the solar spectrum. This would favor the theory that the light really proceeds from the coronal appendage, and that its exterior is made up of a mass of meteors reflecting the light of the sun—a theory that is already supported by the results of polariscopic analysis. It is also stated that M. Tacchini has observed near the limit of the coronal atmosphere the spectrum of a hydrocarbon similar to that which comets give when they are far from the sun.

Function and Structure.—The French Academy of Medicine recently discussed the question whether an identity of action exists between the living tissues of animals and of men. M. Béchamp denied any similarity, and alleged differences in the properties of the salivas of man and animals, and between the milks of man, the cow, and the goat, in support of his view. The answer to this, as suggested by the "Lancet," is that, in the process of evolution, function precedes structure; hence the legitimate corollary is deduced that the properties of a tissue are more delicate tests of its nature than the structure. It is more than probable, however, that in drawing this conclusion we are swerved by the imperfections of our senses, and that molecular structure goes hand-in-hand with function, and that a change in property is accompanied by a corresponding variation in the arrangement of the constituent atoms of a molecule. Every cell and every molecule has its individual characteristics, and these idiosyncrasies may extend to different individuals of the same species, to different species, and to different genera.

A Home-made Microphone.—Some of the readers of this journal may be pleased to have a description of a little microphone that has given good results, and which can be made, in a few minutes, from material at hand. It is represented in the figure of the natural size. It is made from a visiting-card of the ordinary thickness cut square. A round card might look better, but it will give less satisfaction. On the card should be fastened with sealing-wax three thin, light disks of carbon, B B B′, of the quality used in the electric light. The disks



should be placed symmetrically at the angles of an equilateral triangle, and should be put in communication with each other by the copper wires *b b b′*, which are either soldered or stuck tightly into holes made in each disk to receive them. Platinum may be advantageously substituted for copper. The rest of the apparatus consists of a square wooden foot, M, supporting three prismatic rods of carbon, C C C′, arranged so as to correspond exactly with the three disks B B B′. Two of the rods, C C, communicate by the copper or platinum wires *d d* with the common terminal D, while the third rod, C, communicates alone with a second terminal, D′. The upper ends of the charcoal rods should be cut into a bevel-shape—not into a point, for that does not give sufficient contacts. The rods are sealed to the wooden base M. The theory of this microphone is very simple. The current enters, for example, by the terminal D′, follows the rod C′, then the disk B′, whence by the wire *b* it passes by the two disks B to return to the terminal D through the two rods C C. The little instrument may be made very sensitive to the voice and to all sounds, provided the card A is given the proper weight, and is neither too heavy nor too light. The voice, with its timbre, of a person speaking in his usual tone at the other side of the room, can be heard very distinctly in it. The sounds of the piano are particularly well reflected. The apparatus should be placed upon a table two or three metres away from the sound. For a battery to put the microphone in action, I have generally used a small Bunsen element. Two or three Leclanché elements would do as well. I have used a modification of the Leclanché elements, in the shape of a pile made of a plate of zinc and a carbon plate, moistened with a saturated solution of bichromate of potash and hydrochlorate or sulphate of ammonia. It is in fact the bichromate pile without the costly mechanism which is used for relieving the zinc from the action of the acid when the apparatus is at rest. This element does not waste when the current is interrupted, as in the Leclanché pile. A difficulty which arises in the use of the pile, from the penetration of the carbons by the ammoniacal solutions till they attack the wires, has been obviated by M. Préaubert's device of exposing the carbons to a bath of

boiling paraffine, which destroys their capillarity, while it does not affect their conducting power. The superficial paraffine may be scraped off after the bath. Piles may be obtained by this means that will endure indefinitely, and have, apparently, an electromotive force superior to that of a Leclanché pile of the same dimensions.—M. A. Bleunard (*translated for the Popular Science Monthly from La Nature*).

Lightning without Audible Thunder.—A correspondent of "Nature" reports a violent rain and lightning storm which took place near the crest of the Apennines, and during which no sound of thunder was heard. The writer also describes two other such storms that he witnessed on the edge of the Montenegrin highlands. "On these nights," he states, "the lightning was so incessant and vivid that we were able to walk about, choosing our way among the stones and shrubs as readily as by daylight, the intervals between the flashes being, I should judge, never more than a minute, while much of the time they seemed absolutely continuous, the landscape being visible in all details under a diffused violet light. Looking overhead, the movements of the lightning were easily discernible, the locality of the discharges varying from one part of the vault to another in a manner which it was impossible to confound with the reflection of lightning from a distance. Like the storm of last night, those were followed by copious rain, but not a single peal of thunder was heard during the whole night."

Combustion-Products from Different Lights.—The following figures show the amount per hour of combustion-products from several varieties of artificial light. Unless the electric light has some peculiar injurious influence, it has a great superiority on sanitary grounds:

LIGHT OF 100 CANDLES.	Water-vapor, in kilogrms.	Carbonic acid, in cubic metres.	Heat, in calories.
Electric lamp, arc	0	0	57–158
Electric lamp, incandescent	0	0	290–586
Gas, argand-burner	0·86	0·46	4860
Lamp, petroleum, flat flame	0·80	0·95	7200
Lamp, colza-oil	0·85	1·00	6800
Candle, paraffine	0·99	1·22	9900
Candle, tallow	1·05	1·45	9700

NOTES.

Mr. Robert E. C. Stearns, in a paper read before the California Academy of Sciences, announces his conclusion, from his studies of the shells of the Colorado Desert and the region farther east (particularly from studies of *Physa* and *Anodonta*), that every item bearing upon the geographical distribution of the species indicates the mountain-lakes as the sources whence they are derived; points to their descent from northerly regions as well as from higher altitudes; and contributes additional testimony as to the antiquity of these widely spread though inferior forms of life.

General Richard D. Cutts, of the United States Coast Survey, died in Washington, December 13th, in the seventy-seventh year of his age. He had been connected with the Coast Survey during the greater part of his life, and was at the time of his death first assistant superintendent of the service.

In a paper before the American Association on the "Serpentine of Staten Island, N. Y.," Dr. T. Sterry Hunt expressed himself in favor of the opinion of Dr. Britton, of the School of Mines, Columbia College, that the belt containing the mineral is a protruding portion of the Eozoic series. The appearance of isolated hills and regions of serpentine is common in other regions, and is by Dr. Hunt explained by the consideration that this very insoluble magnesian silicate resists the atmospheric agencies which dissolve limestones and convert gneisses to clay—the removal of which rocks leaves exposed the included beds and lenticular masses of serpentine. Similar appearances are seen in many parts of Italy, where ridges and bosses of serpentine are found protruding in the midst of Eocene strata, and have hitherto, by most European geologists, been regarded as eruptive masses of Eocene age. Mather, who described the Staten Island locality more than forty years ago, also looked upon the serpentine as an eruptive rock.

A curious instance of the kindling of a fire by means of the concentration of the sun's rays by a globular water-bottle through which they passed is related by a correspondent of "La Nature." The day was cold, but the sun shone brightly; the bottle, an "onion-shaped" flask, filled with water so as to form a perfect lens, sat upon the table. The starting of the fire, which would have caused great damage if the relater of the incident had not been present to extinguish it, was revealed by the smoke. A deliberate experiment was made on the next day, with complete success, in kindling a fire by this means.

THE "Pall Mall Gazette" cites some more cases illustrating the quality of the learning furnished by the English board-schools. The study was geography. The children were able to give an accurate list of the exports of Norway, but could not recall the picture of a fiord. They knew that the latitude of Paris was 49°, but when asked, "What is latitude?" they were either dumb, or gave such answers as—"Latitude means lines running straight up"; "Latitude means zones or climate"; "Latitude is measured by multiplying the length by the breadth." Correct lists of imports were given, but customs duties were defined, by a girl, "Customs are ways, duties are things that we have to do, and we ought to do them"; by a boy, "Customers' duties are to go to the places and buy what they want, not stopping about, but go out when they are done."

ACCORDING to tables prepared by Dr. Daniel Draper, of the New York Meteorological Observatory, Greenwich Observatory had 1,245 hours of sunshine in 1878, in a possibility of 4,447, while New York had 2,936 hours, in a possibility of 4,449; and in 1879, Greenwich had 977 hours, and New York 3,101 hours.

PROFESSOR SVEN NILSSON, of the Lund University, Sweden, a distinguished zoölogist, died November 30th, at the age of ninety-seven years.

IT is proposed to hold next year, in the building of the International Fisheries Exhibition at South Kensington, an exhibition illustrating the relations of food, dress, the dwelling, the school, and the workshop, with health. The exhibition will be divided into sections of education and health, and further into six principal groups: 1. Food-matters and their preparation; 2. Dress, with specimens of different styles and materials; 3, 4, and 5. What pertains to the healthful construction and fitting of the dwelling, the school, and the workshop; and, 6. All that relates to primary, technical, and art education.

POPULAR lore teaches several signs by which it pretends to determine from the weather on a particular day what the weather will be for a longer or shorter time in the future. M. A. Lancaster reports, in "Ciel et Terre" of Brussels, concerning a test he has made of one of these signs. It is that of St. Médard's day, or the 8th of June, concerning which a proverb is rife in the Continental countries that, if it rains then, it will rain for forty days afterward. M. Lancaster examined the record for fifty years, from 1833 to 1882, and found from it that, as a rule, it rained about as much and as often during the forty days following the 8th of June when it did not rain on that day as when it did. Taking the averages of all the years, there was a difference of 2·3 days, or less than one seventeenth, and of twelve millimetres (88·1–77·6) of rain in favor of the rainy St. Médard: not enough, certainly, on which to found a rule.

MR. JOHN ELIOT HOWARD, F. R. S., a well-known chemist and quinologist of London, died in November last, at the age of seventy-six years. His father, Mr. Luke Howard, F. R. S., was in his own day distinguished as a meteorologist.

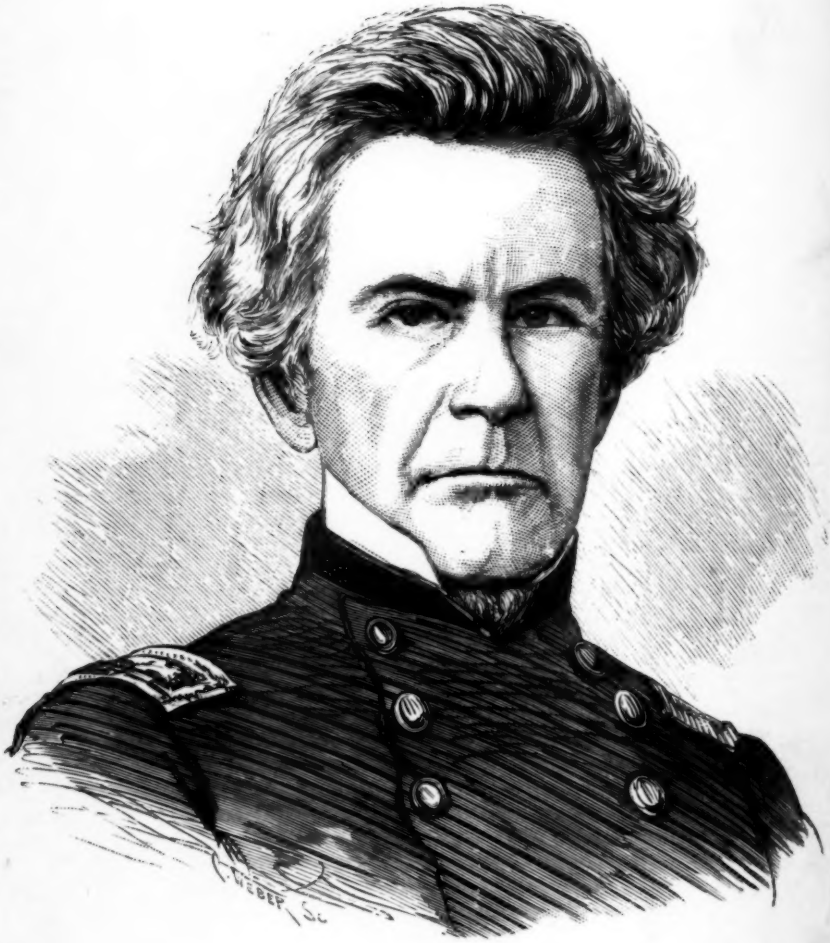
TURGENIEFF, the great Russian novelist, recently deceased, had the heaviest brain that has yet been weighed—2,012 grammes. The average weight of the human brain is 1,390 grammes. The statistics of brain-weights so far gathered do not show that great intellects are marked by heavy brains. Cuvier's brain, 1,800 grammes, was considerably larger than the average, while Gambetta's was remarkably small. The brains of Raphael, Cardinal Mezzofanti, Charles Dickens, Lord Byron, and Charles Lamb, did not exceed the average, and only Mezzofanti's reached it.

LIEUTENANT WISSMANN, a German explorer, is about to make another journey into Africa, the cost of which is defrayed by private contributions. His object will be to explore the Kaisai from Mukenge to its mouth into the Congo. The success of the expedition is likely to have an important bearing on the extension and development of trade on the Congo, and to contribute much to geographical knowledge; for the contemplated route will intersect the southern and unexplored part of the bend of the great river, probably in the middle.

THE remains of Commandant Langle and other companions of the explorer La Pérouse, who were massacred by savages in the last century, have been discovered by the Roman Catholic missionaries on the Island of Tutuila, where the massacre occurred. A memorial chapel is to be built at the spot where they are buried.

THE Italian traveler Sacconi, who was exploring the country of the Somaulis under the auspices of the Geographical Society of Milan, was murdered by the natives on the 12th of August. His death puts an end to one of the most important explorations of the day into a country concerning which many questions still remain to be settled.

AMONG the 20,000 articles of bronze belonging to the lake-dwellers so far found in Switzerland, about 30 per cent are rings, 17 per cent bracelets, 4 per cent knives, 3 per cent needles, 0·4 per cent hammers, and 0·2 per cent fibulæ.



ORMSBY MACKNIGHT MITCHEL.